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PNL-3904
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COASTAL ZONE WIND ENERGY

Part II: Validation of the coastal zone wind power potential: A summary of the field experiment.

PNL--3904

DE82 008867

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June 1980

Prepared for
Pacific Northwest Laboratory
Under Agreement B-93492-A-Q

Pacific Northwest Laboratory
Richland, Washington 99352

EXECUTIVE SUMMARY

Procedures have been developed to determine the wind power potential of the coastal region from Maine to Texas. The procedures are based upon a climatological analysis and a mesoscale numerical model. The results of this procedure are encouraging but need to be tested. In January-February 1980 a field measurement program was carried out over the Delmarva Peninsula centered on Wallops Island and extending into the Atlantic Ocean and Chesapeake Bay to provide an observational basis on which to test our wind assessment methods.

The field experiment is described in this report. Listings of the measurements made by aircraft, tethered balloon, rawinsonde kites, tower mounted anemometry and surface thermometry are given together with sample results. The analysis of these data and the comparison between them and the model predicted fields are presented by Garstang, Pielke and Snow (1981b).

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1. INTRODUCTION

In previous work, which has led to a procedure to determine the wind power potential of the coastal region from Maine to Texas (Garstang, Pielke and Snow 1981a), climatological analysis (Garstang, et al., 1980; Lindsey, 1980) has been combined with mesoscale and numerical modeling (Garstang, Pielke and Snow, 1980). The approach to coastal wind energy assessment that has been developed provides a quantitative method by which the local effects can be interpreted in terms of large scale atmospheric fields. A relatively detailed spatial description, with a resolution of 10 km, describes the seasonal and annual wind power potential over a domain of 300x300 km. Regions of persistently strong and weak winds are identified and the goal of evaluating the potential of the wind energy resource and of selecting an optimum location (on a scale of 10 km) has been substantially advanced.

The method is potentially very powerful for it allows assessment to be made rapidly and economically. It can be applied in regions where inadequate climatological records exist and, because the method is based upon physical principles, it can be extended to regions other than the Gulf and East coasts of the United States where the method was developed.

The crucial question which must be answered, however, is how reliable is the method? A field program centered on the Wallops Island on the eastern shore of Virginia was carried out in January-February 1980 to provide measurements which would permit an explicit evaluation of the energy resource prediction scheme which we have developed. The purpose of this report is to summarize the design of the field experiment and describe what was done in the field. Only some results will be given. The comparison of energy resource predictions based upon our method to the observations is described by Garstand, Pielke and Snow (1981b).

2. DESIGN OF THE FIELD EXPERIMENT

The purpose of the field experiment was to obtain observations of the lower atmospheric fields of motion and state which would allow quantitative comparison with corresponding fields that would be predicted from our climatological-numerical scheme. The space and time scales of the predictions by numerical method are in the order of a few 100 km and 24 hours. Both the space and time scales are placed in the context of larger scales via climatological analysis. Thus an experimental region of 120x30 km was chosen in a location and at a time of year which previous work (Garstang, et al., 1980) dictated as significant.

Figure 1 shows the location of the experiment grid in relation to model predicted wintertime daily average 10-100 m layer-mean power density. Figure 1 illustrates that the experiment grid intersects the strongest gradients in power density, extending across a region of minimum power and into a region of maximum power. All of our other estimates of the power density distribution (Garstang, Pielke and Snow 1980) for the Chesapeake Bay area suggest a similar distribution of the centers of maximum and minimum power density.

The experiment region (Figure 2) was bounded by an outer and inner rectangle which represented the track of a research aircraft (NCAR Queen Air) flying at 50 and 150 m. A tethered balloon system at Site 63 and a 300 ft tower at Site 61 provided vertical profiles of the wind and temperature to 100 m. Kite soundings to 100 m were made at 11 other locations indicated in Figure 2. Wind speed and direction were measured continuously at all stations at 6 m above the ground. At Site 42 wind measurements were made at 6 and 8 meters and at Site 33 soil moisture and temperature measurements were also made.

The aircraft measured a full range of meteorological variables at flight level together with the surface temperature by infrared radiometer. Table 1 provides a detailed listing of the aircraft measurements. Table 2 shows the flights made in each of two patterns illustrated in Figures 3a and b. A total of over 72 hours of research flight time was logged during the experiment.

A combination of all of the measurements will provide wind, temperature and other fields through the first 150 meters of the atmosphere which can be described over time during a given day and for each day of the experiment. Model generated fields of the same variables for the same times will be obtained. Double blind experiments will then be carried out between the observed and model predicted fields, i.e., the analyst will not know the day/time of either the observed field or the model predicted field. The skill of the model will be measured in terms of the double blind experiments.

3. THE MEASUREMENTS

a) Aircraft

All of the aircraft measurements listed in Table 1 are recorded on magnetic tape. Summaries at 10 sec^{-1} are on microfilm. Table 1 lists all flight dates, times, duration and type of pattern. Figure 4 shows a typical microfilm product of wind vectors over a segment of the track. Figure 5a-c shows the wind field at 150 m over the experiment region over a period of 1 day.

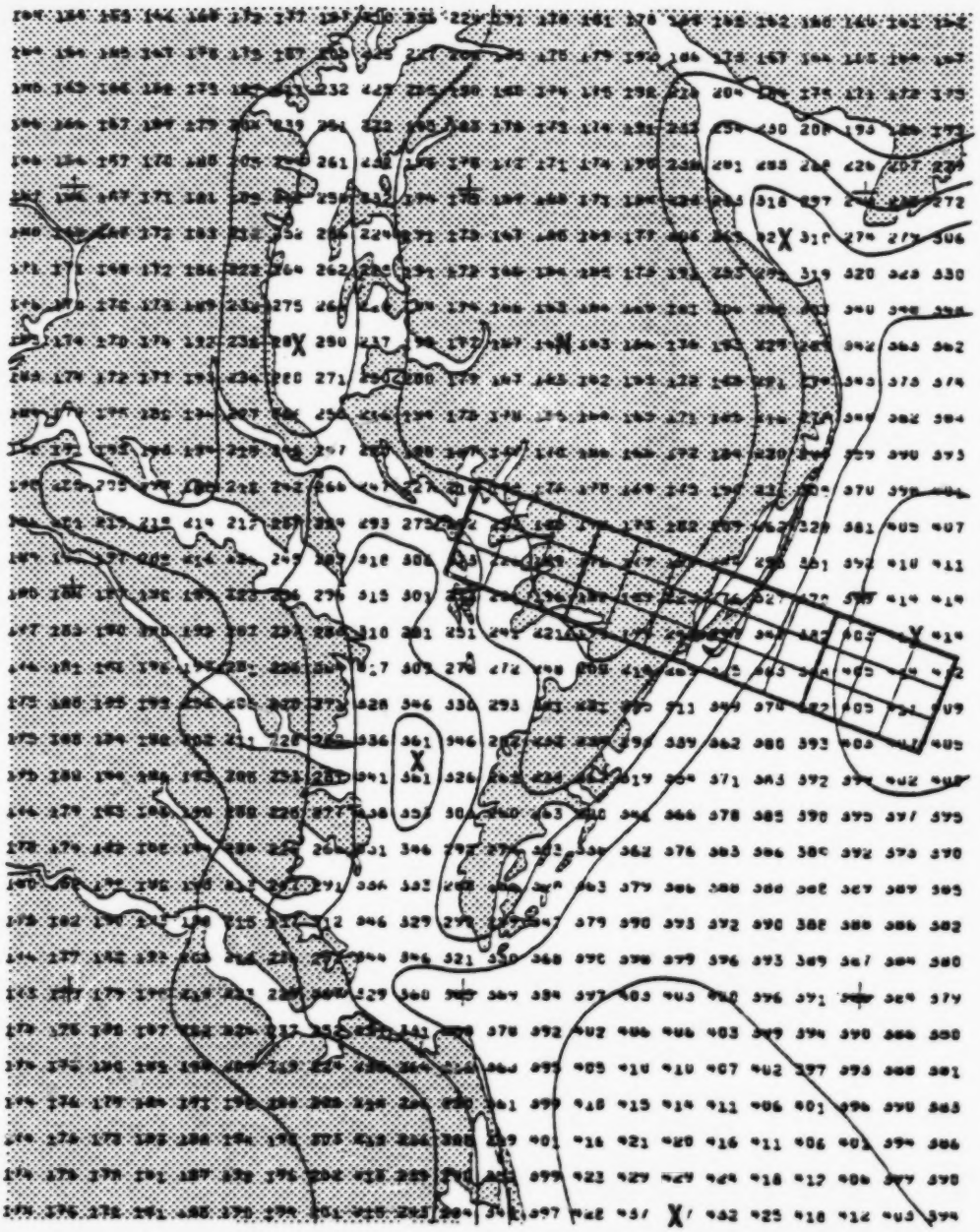


Figure 1. Outline of 120x30 km observational network superimposed upon a wintertime daily average, layer-mean (10 to 100 m) power density distribution. Numbers are in W m^{-2} and isolines of power density are in intervals of 50 W m^{-2}.

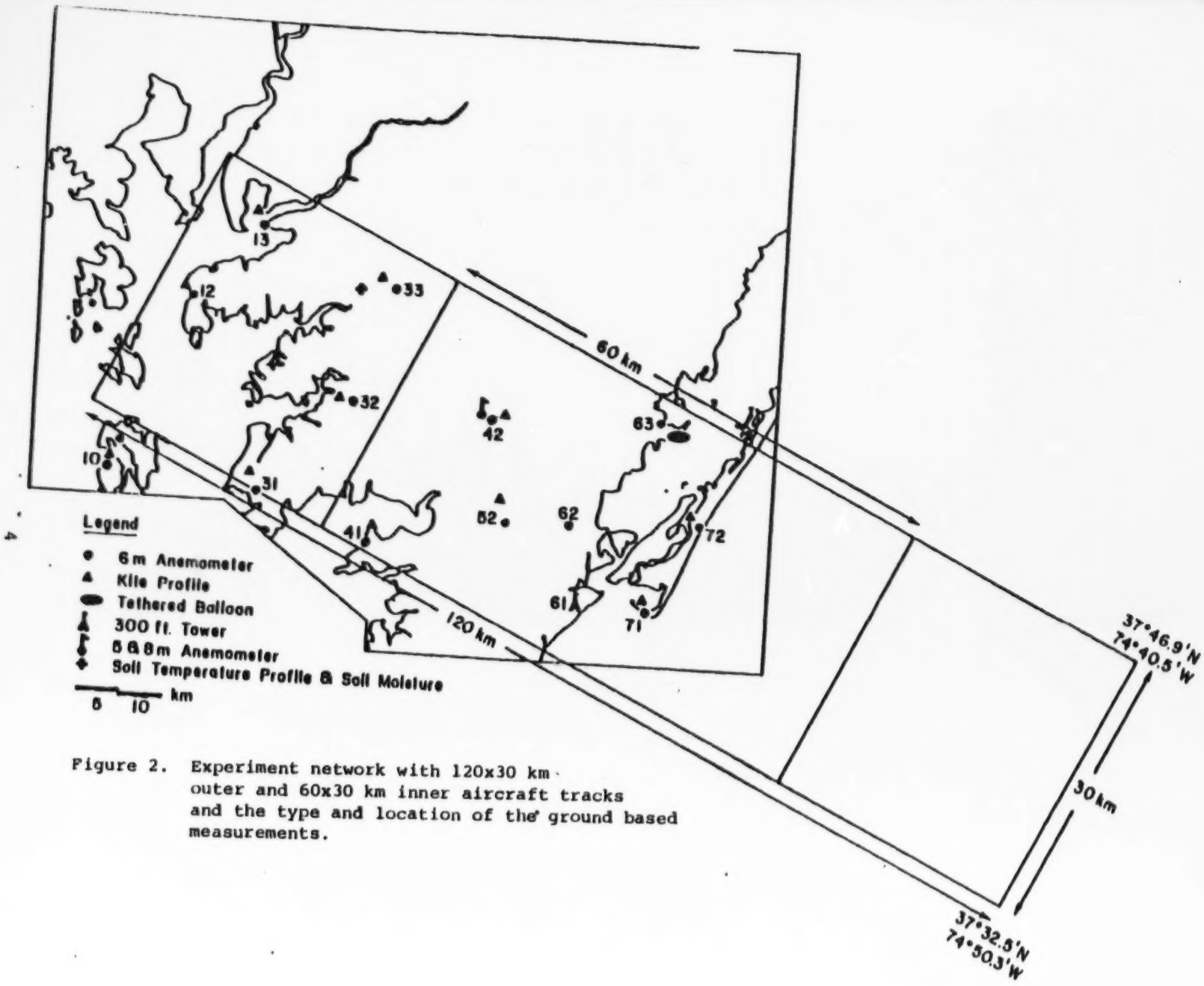


Figure 2. Experiment network with 120x30 km outer and 60x30 km inner aircraft tracks and the type and location of the ground based measurements.

Table 1. NCAR Queen Air instrumentation as configured for the Coastal Zone Wind Energy Experiment, January-February 1980.

PARAMETER MEASURED	SYMBOL	INSTRUMENT TYPE	RANGE	INSTRUMENT ACCURACY	RESOLUTION	SAMPLE RATE (Hz)	ACTIVE FILTERS (CUTOFF Hz)	SENSOR LOCATION
Aircraft latitude	ALAT	Inertial Nav. Sys.	± 90°	± 0.066°	0.001°	5		Inside cabin over wing spar
Aircraft longitude	ALON	Inertial Nav. Sys.	± 180°	± 0.066°	0.001°	5		" "
Aircraft Ground Speed	XVI, YVI	Inertial Nav. Sys.	0 to 400 m/s	± 1 m/s	0.04 m/s	5		" "
Aircraft Vertical Velocity	VZI	Inertial Nav. Sys.	± 50 m/s	± 0.10 m/s	0.012 m/s	5		" "
Aircraft True Heading	THI	Inertial Nav. Sys.	0 to 360°	± 0.05°	0.001°	5		" "
Inertial Wander Angle	ALPHA	Inertial Nav. Sys.	0 to 360°	± 0.05°	0.001°	5		" "
Aircraft Pitch Angle	PITCH	Inertial Nav. Sys.	± 45°	± 0.008°	0.005°	5		" "
Aircraft Roll Angle	ROLL	Inertial Nav. Resolver	± 45°	± 0.008°	0.005°	5		" "
Inertial Platform Heading	PLTHDG	Inertial Nav. Resolver	± 45°	± 0.008°	0.005°	5		" "
Total Air Temperature	TTW	Platinum Resistance	-60 to 40°	± 0.5°C	0.016°C	5	1	Under left wing
Total Air Temp Reverse Flow	TTRF	Platinum Resistance	-60 to 40°C	± 0.5°C	0.02°C	5	1	" "
Total Air Temp (heated)	TTRH	Platinum Resistance	-60 to 40°C	± 0.5°C	0.008°C	5	1	End of noseboom
Moisture Content	DP	Thermoelectric Hygrometer	-50 to +50°C	± 0.5°C 0°C ± 1.0°C 0°C	0.05°C	5	1	Left aft fuselage
Static Pressure	PSF, HP	Variable Capacitance	300 to 1035 mb	± 1 mb	0.09 mb	5	1	Inside cabin from aft fuselage
Static Pressure	PSB, HP	Variable Capacitance	300 to 1035 mb	± 1 mb	0.18 mb	5	1	Noseboom from gust probe pitot

Table 1 (cont.)

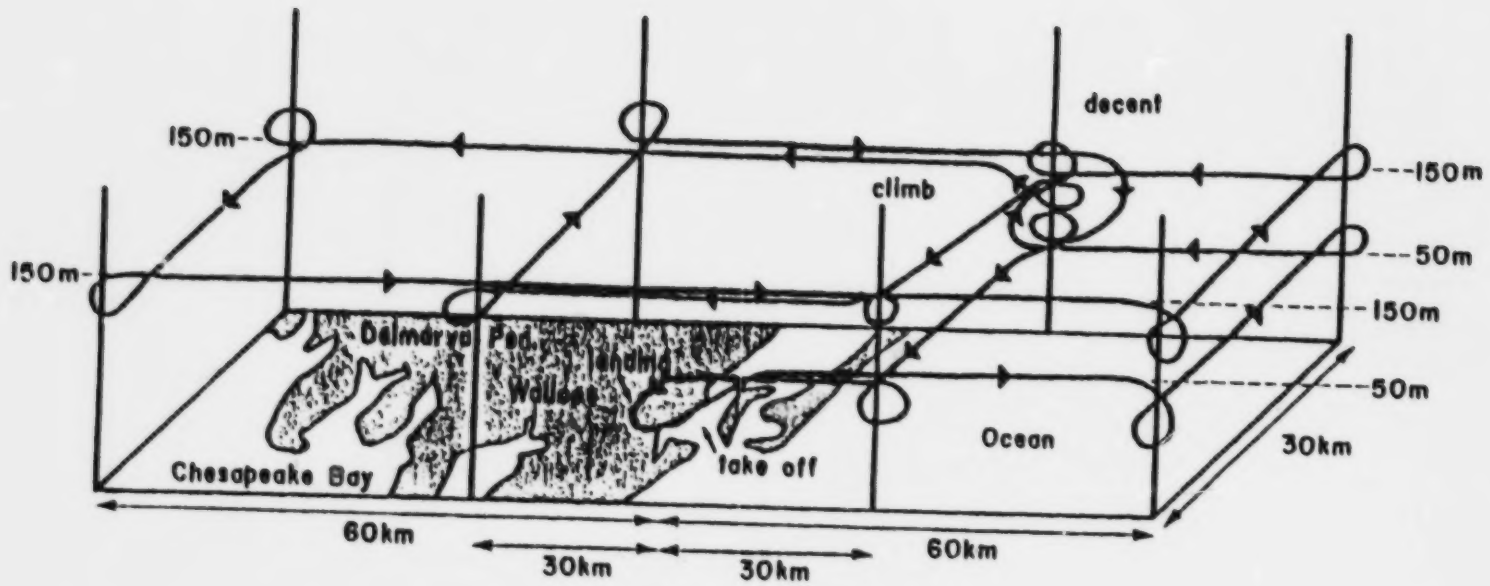
PARAMETER MEASURED	SYMBOL	INSTRUMENT TYPE	RANGE	INSTRUMENT ACCURACY	RESOLUTION	SAMPLE RATE (Hz)	ACTIVE FILTERS (CUTOFF Hz)	SENSOR LOCATION
Indicated Airspeed	QCW	Variable Capacitance	0 to 125 m/s	± 1.0 m/s	0.04 m/s	5	1	Inside cabin right wing pitot
Indicated Airspeed	QCB	Variable Capacitance	0 to 125 m/s	± 1.0 m/s	0.08 m/s	5	1	Inside noseboom from gust probe
Geometric Altitude	HGM	Radio Altimeter	0 to 762 m	± 1.5m,0-30m ± 8m, 30-150m ± 53m,150-762m	0.19 m	25	10	Under fuselage
Radiometric Sfc. Temp.	PRT-5	Balometric Radiometer	-20 to ±75°C	± 0.5°C	0.04°C	5	1	Downward pointing
Angle of Attack	ADIF	Variable Capacitance	± 10°C	± 0.5°C	0.005°C	25	10	Inside noseboom from gust probe
Angle of Sideslip	BDIF	Variable Capacitance	± 10°C	± 0.5°	0.005°	25	10	Inside noseboom from gust probe
Photography	---	16 mm Time Lapse Camera	0-20 fr/sec	---	---	20		Forward looking camera

Table 2. Summary of research aircraft flights during the Coastal Zone Wind Energy Experiment, 24 January-5 February 1980.

Date	Flight #	Pattern	Take-off Time	Landing	Duration (hr-min)	Pilot	Observer	Remarks
1/24/80	1	1	07:23	10:26	3+03	Orum	Snow	
	2	2	11:44	13:38	1+54	Summers	Snow	
	3	1	14:53	17:45	2+52	Summers	Snow	
1/25/80	4	2	07:59	10:01	2+02	Orum	Snow	
	5	2	14:00	15:52	1+52	Summers	Snow	
1/26/80	6	2	07:51	09:52	2+01	Orum	Garstang	
	7	2	13:48	15:50	2+02	Summers	Garstang	
1/28/80	8	1	07:05	09:55	2+50	Summers	Snow	
	9	2	13:36	15:37	2+01	Orum	Garstang	
	10	1	14:25	17:10	2+45	Orum	Snow	
1/29/80	11	2	08:04	09:59	1+55	Summers	Snow	
	12	2	11:25	13:28	2+03	Orum	Garstang	
1/30/80	13	1	07:06	09:56	2+50	Orum	Snow	
	14	2	11:16	13:34	2+18	Summers	Garstang	
	15	1	14:19	17:05	2+46	Summers	Snow	
2/1/80	16	1	07:05	10:09	3+04	Orum	Snow	min. alt. 200'
	17	2	11:17	13:22	2+05	Orum	Garstang	
	18	1	14:25	17:23	2+58	Summers	Snow	min. alt. 200'
2/2/80	19	2	07:59	10:06	2+07	Orum	Snow	min. alt. 200'
	20	2	14:04	16:06	2+02	Summers	Snow	min. alt. 200'
2/3/80	21	1	07:01	10:03	3+02	Summers	Snow	
	22	2	11:02	13:12	2+10	Summers	Garstang	
	23	1	14:23	17:10	2+47	Orum	Snow	

Table 2 (cont.)

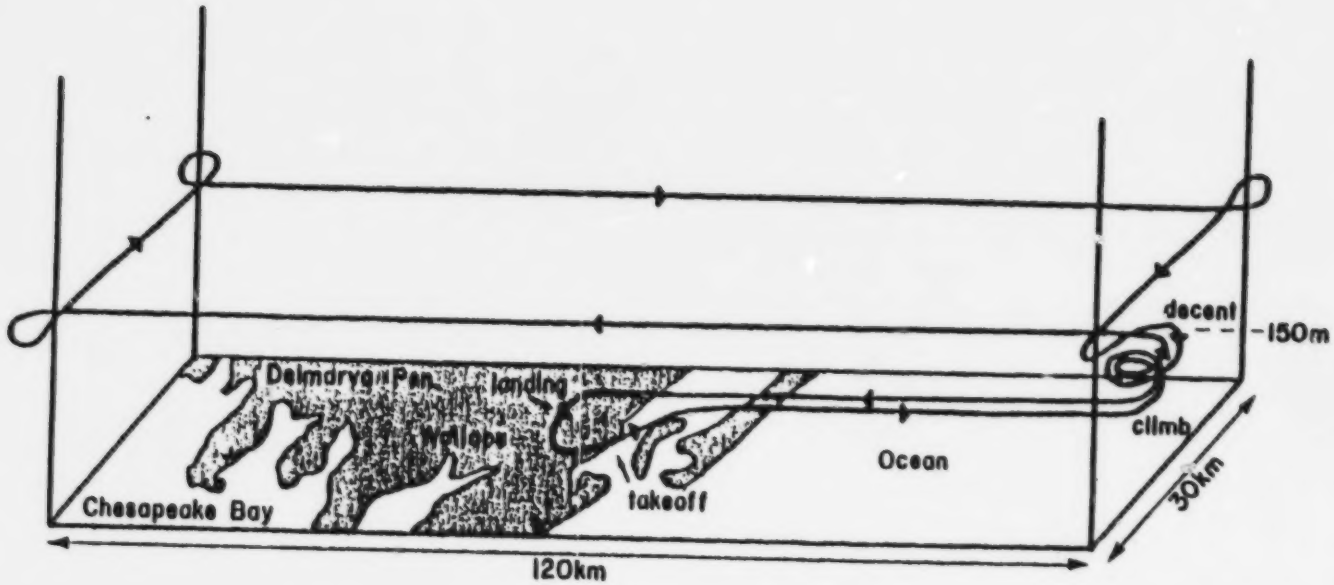
Date	Flight #	Pattern	Take-off Time	Landing	Duration (hr-min)	Pilot	Observer	Remarks
2/4/80	24	1	07:00	09:55	2+55	Summers	Snow	
	25	2	10:30	12:25	1+55	Orum	Garstang	
	26	1	14:28	16:26	1+58	Orum	Snow	
2/5/80	27	1	06:57	09:56	2+59	Orum	Snow	
	28	2	10:59	12:36	1+37	Summers	Snow	



PATTERN I DOUBLE BOX

(-540km or - 2 ½ hrs)

Figure 3a. Aircraft flight pattern: Pattern 1 double box at 50 and 150 m with calibration legs at 150 m.



PATTERN 2 SINGLE BOX (~420km or ~13/4hrs)

Figure 3b. Aircraft flight pattern: Pattern 2 single box at 150 m with calibration leg at 50 m.

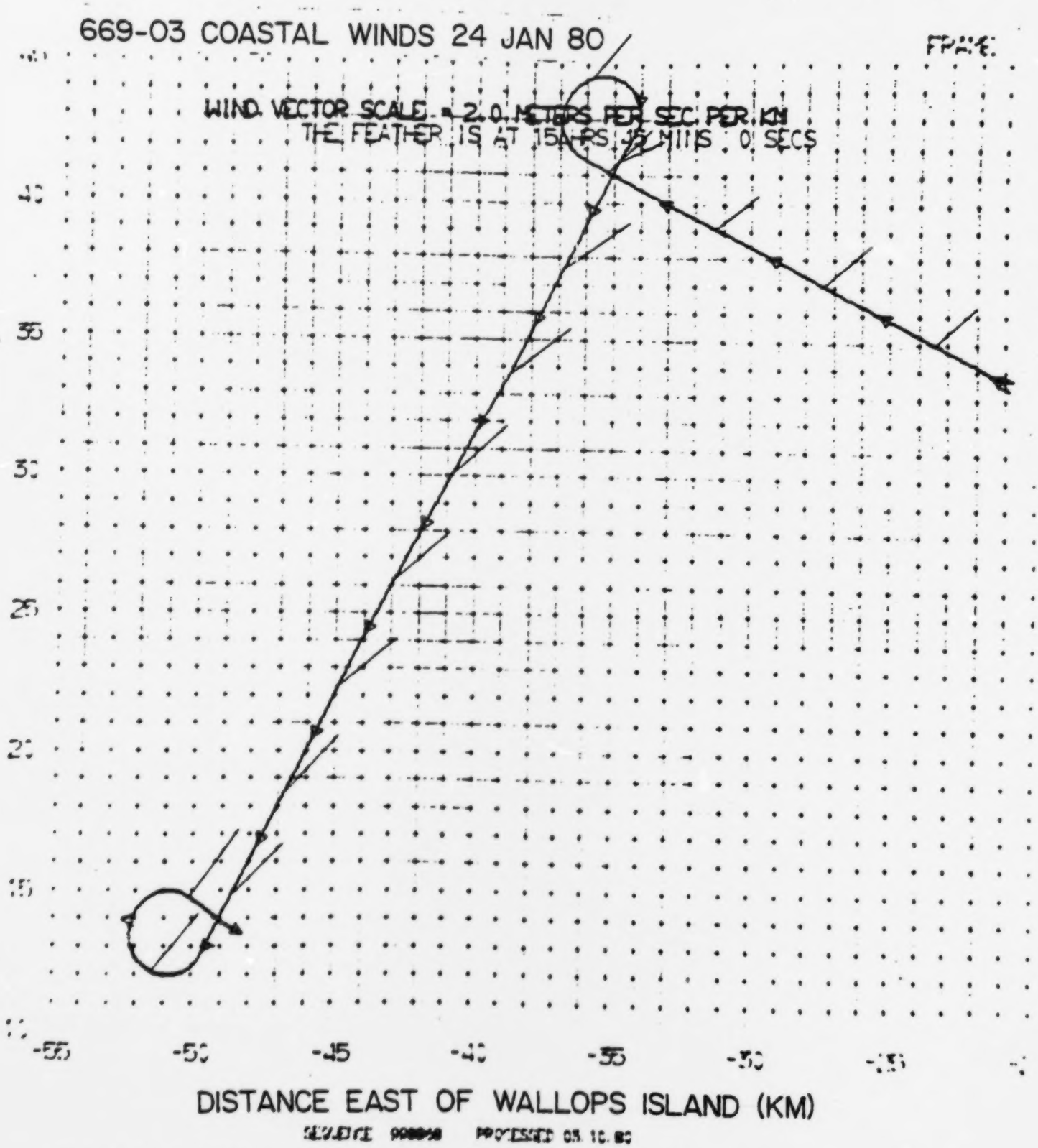


Figure 4. Printer copy of wind field over segment of track from the aircraft microfilm.

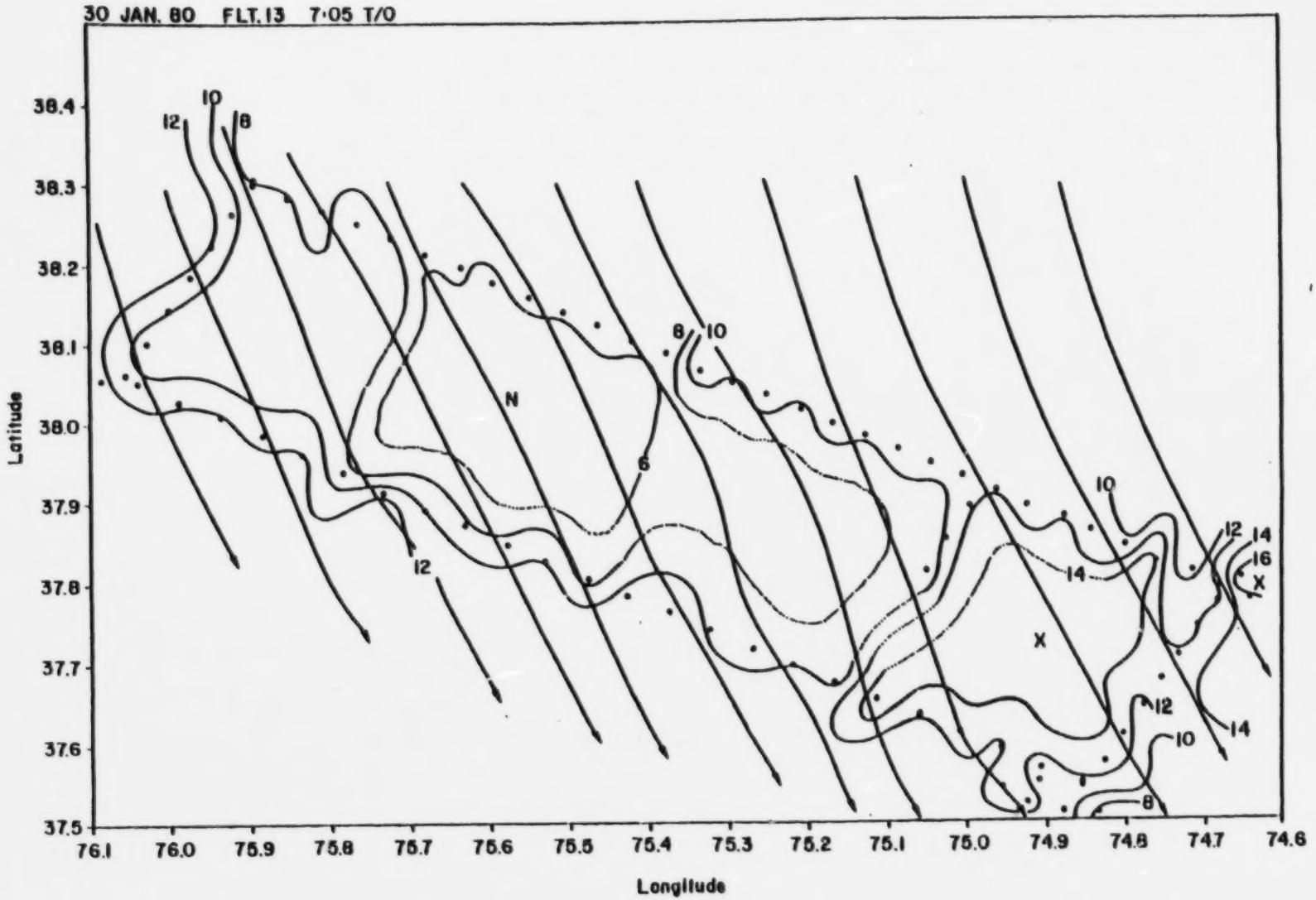


Figure 5a. Aircraft winds at 150 m on 30 January 1980 for Flight 13, early morning, 0705 to 0956 EST. Isotachs are in m s^{-1} representing an average wind over a path length of 5 km centered on the dot. X represents centers of maximum, N centers of minimum. See Table 2 listing.

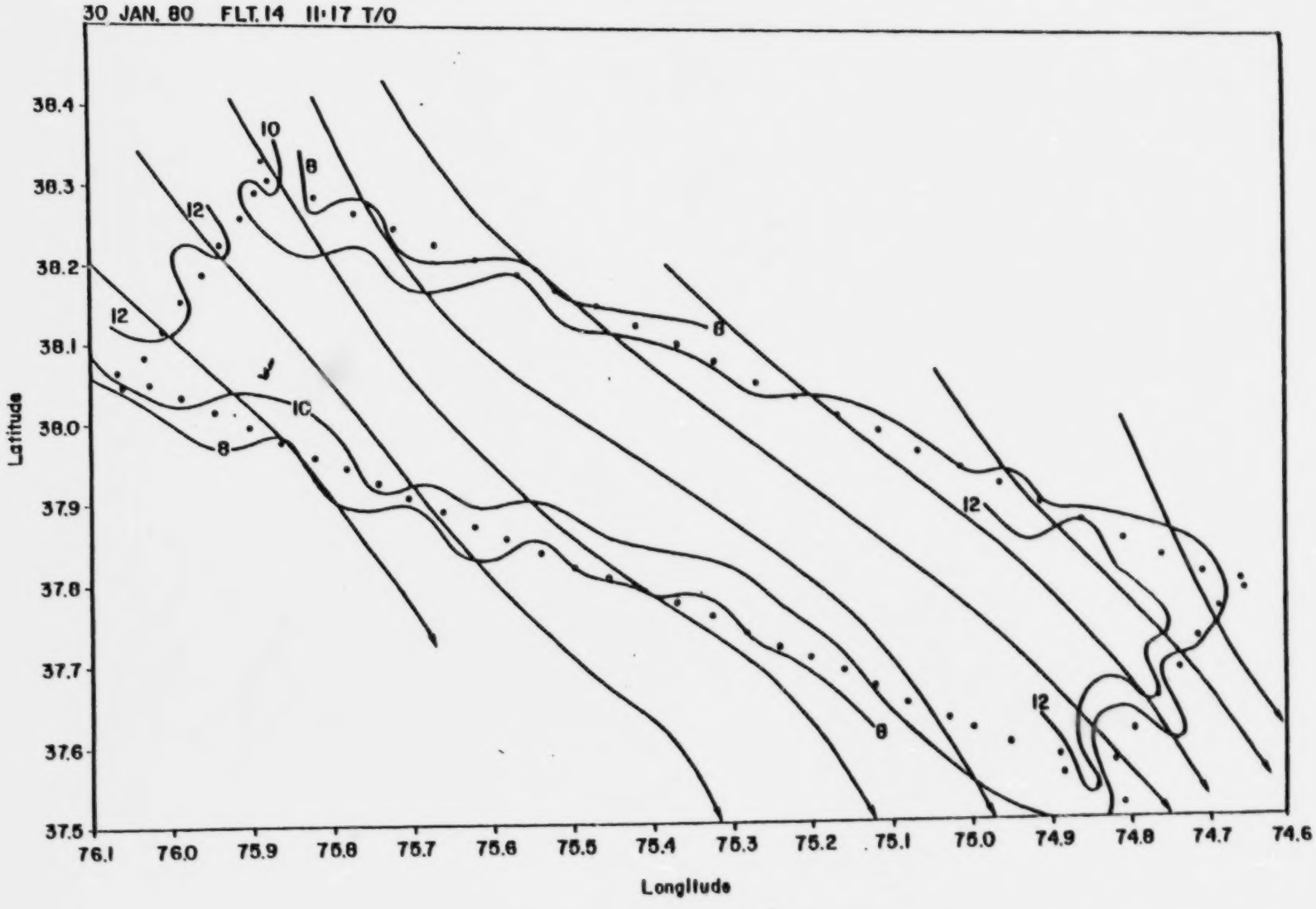


Figure 5b. Aircraft winds at 150 m on 30 January 1980 for Flight 14, midday, 1137 to 1334 EST. Same as Figure 5a.

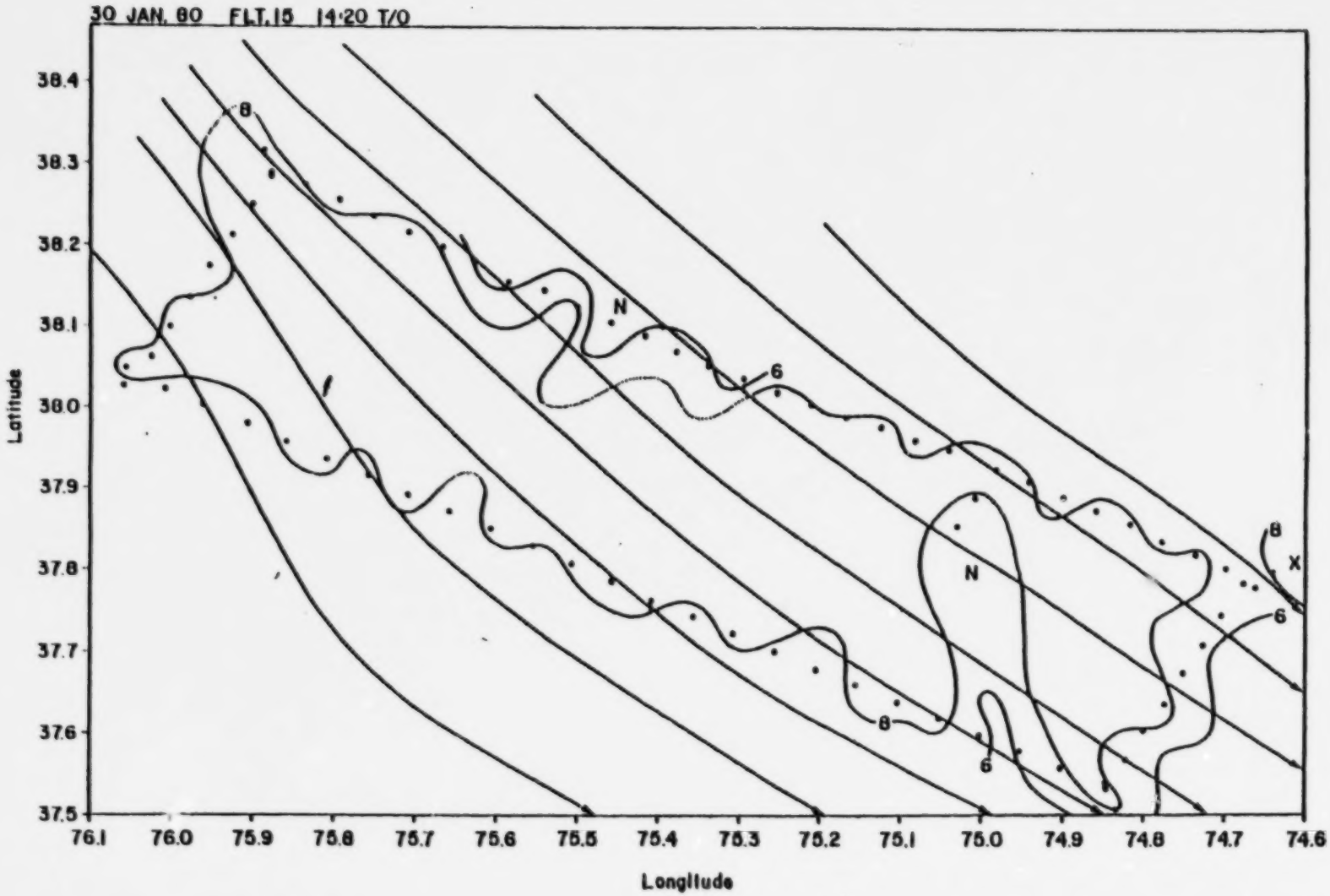


Figure 5c. Aircraft winds at 150 m on 30 January 1980 for Flight 15, late afternoon, 1420 to 1705 EST. Same as Figure 5a.

b) Tethered Balloon

Two hundred and sixty-eight soundings were made from the surface to a maximum of 150 m. Table 3 lists the dates and times of all tethered balloon soundings. Figures 6a-c illustrate a sequence of wind speed, wind direction and temperature soundings made on 29 January 1980. At the intermediate times between soundings, wind velocity and temperature were recorded continuously at or near the 150 m level. All tethered balloon soundings are in digital form on magnetic tape.

c) Kite Soundings

Kite soundings were made from 11 stations to a target height of 100 meters. Table 4 lists the kite soundings taken during the experiment. Figures 7a-c illustrate kite soundings at a single station (Site 72) on the same day (29 January 1980) as the tethered balloon (Site 62) soundings illustrated in Figures 6a-c and the Wallops 300 ft tower (Site 61) illustrated in Figures 8a-c. Table 5 shows the numerical values of wind velocity as measured on the 300 ft tower and by the kite at Site 72.

A kite-tethered balloon intercomparison was carried out on 5 February 1980. All kite data is in the form of tabulations.

d) 300 ft Tower

Observations of wind speed and direction were made throughout the experiment at 5 minute and 50 ft intervals from the 300 ft NASA Wallops Tower. Figures 8a-c illustrate the 300 ft tower profiles as a comparison with Figures 6 and 7 for the tethered balloon and kite profiles. The 300 ft tower data is on magnetic tape and in hard copy form.

e) 6 Meter Towers

Observations of wind speed and direction were made at 6 meters at all stations during the experiment. The wind record is in analog chart form which will be read every 5 minutes and placed on magnetic tape.

f) Other Measurements

Soil temperatures and soil moisture measurements were made at one location (Site 33) to determine soil heat and moisture flux.

Wind profile measurements were made at 2 levels (6 and 8 meters) at one location (Site 42) to determine friction velocity and roughness lengths.

Table 3. Summary of tethered balloon soundings (Station 63, Figure 2) during the Coastal Zone Wind Energy Experiment, 24 January-5 February 1980. Soundings are made from the surface to a maximum height of 150 m with a vertical resolution of 2 m. Wind direction, wind speed and air temperature are recorded.

Profile #	Date	Time Start (EST)	Time Stop (EST)
1	1/24/80	16:40:00	16:41:55
2	"	16:45:00	16:46:55
3	"	16:49:00	16:50:53
4	"	16:53:00	16:54:55
5	1/25/80	07:46:00	07:47:57
6	"	07:48:28	07:50:28
7	"	07:50:58	07:52:55
8	"	08:02:00	08:04:00
9	"	08:04:30	08:06:27
10	"	08:30:00	08:31:59
11	"	08:32:29	08:34:24
12	"	09:00:00	09:01:59
13	"	09:02:34	09:04:28
14	"	09:30:00	09:31:59
15	"	09:32:29	09:34:23
16	"	10:00:00	10:01:58
17	"	10:02:28	10:04:22
18	"	10:30:00	10:31:58
19	"	10:32:28	10:34:24
20	"	11:00:00	11:01:55
21	"	11:02:25	11:04:20
22	"	11:30:00	11:31:59
23	"	11:32:29	11:34:24
24	"	12:00:00	12:01:59
25	"	12:02:29	12:04:25
26	"	12:30:00	12:31:59
27	"	12:32:29	12:34:25
28	"	13:00:00	13:01:59
29	"	13:02:29	13:04:25
30	"	14:00:00	14:01:58
31	"	14:25:00	14:26:56
32	"	14:33:00	14:34:58
33	"	14:45:13	14:47:06
34	"	15:00:00	15:01:59
35	"	15:02:29	15:04:24
36	"	15:30:00	15:31:58
37	"	15:32:28	15:34:22
38	"	16:00:00	16:01:59
39	"	16:02:27	16:04:22
40	"	16:30:00	16:31:57
41	"	16:32:27	16:34:24
42	"	17:02:00	17:04:00

Table 3 (cont.)

Profile #	Date	Time Start (EST)	Time Stop (EST)
43	1/26/80	09:47:00	09:48:56
44	"	10:07:00	10:09:10
45	"	10:09:40	10:11:35
46	"	10:30:00	10:32:09
47	"	10:32:34	10:34:34
48	"	11:05:00	11:07:02
49	"	11:07:32	11:09:29
50	"	11:30:00	11:32:03
51	"	11:32:32	11:34:26
52	"	12:00:00	12:01:58
53	"	12:02:28	12:04:22
54	"	12:30:00	12:32:00
55	"	12:32:30	12:34:24
56	"	13:00:00	13:01:59
57	"	13:02:29	13:04:23
58	"	13:30:00	13:31:58
59	"	13:32:29	13:34:23
60	"	14:00:00	14:01:58
61	"	14:02:28	14:04:22
62	"	14:30:00	14:31:59
63	"	14:32:29	14:34:23
64	"	15:00:00	15:01:58
65	"	15:02:28	15:04:22
66	"	15:30:00	15:31:57
67	"	15:32:27	15:34:21
68	"	16:00:00	16:02:00
69	"	16:02:30	16:04:25
70	"	16:30:00	16:31:59
71	"	16:32:29	16:34:23
72	"	17:00:00	17:01:59
73	1/28/80	07:35:00	07:36:58
74	"	07:40:00	07:42:02
75	"	07:42:30	07:44:34
76	"	08:00:00	08:02:07
77	"	08:02:37	08:04:40
78	"	08:30:00	08:32:07
79	"	08:32:37	08:34:40
80	"	09:00:00	09:02:06
81	"	09:02:36	09:04:39
82	"	09:30:00	09:32:07
83	"	09:32:37	09:34:38
84	"	10:00:00	10:02:06
85	"	10:02:36	10:04:37
86	"	10:30:00	10:32:07
87	"	10:32:37	10:34:39
88	"	11:00:00	11:02:07

Table 3 (cont.)

Profile #	Date	Time Start (EST)	Time Stop (EST)
89	1/28/80	11:02:37	11:04:36
90	"	11:30:00	11:32:07
91	"	11:32:37	11:34:39
92	"	12:00:00	12:02:08
93	"	12:02:38	12:04:40
94	"	12:30:00	12:32:07
95	"	12:32:37	12:34:39
96	"	13:00:00	13:02:08
97	"	13:02:38	13:04:41
98	"	13:30:00	13:32:09
99	"	13:32:36	13:34:40
100	"	14:00:00	14:02:09
101	"	14:02:39	aborted
102	"	14:30:00	14:32:08
103	"	14:32:38	14:34:40
104	"	15:00:00	15:02:08
105	"	15:02:38	15:04:40
106	"	15:30:00	15:32:07
107	"	15:32:37	15:34:38
108	"	16:00:00	16:02:08
109	"	16:02:38	16:04:40
110	"	16:30:00	16:32:07
111	"	16:32:37	16:34:38
112	"	17:00:00	17:02:09
113	1/29/80	07:30:00	07:32:15
114	"	07:35:00	07:37:15
115	"	07:37:45	07:39:45
116	"	08:00:00	08:02:09
117	"	08:02:39	08:04:41
118	"	08:34:00	08:36:07
119	"	08:36:37	08:38:39
120	"	09:00:00	09:02:07
121	"	09:02:39	09:04:41
122	"	09:30:00	09:32:08
123	"	09:32:38	09:34:41
124	"	10:00:00	10:02:08
125	"	10:02:38	10:04:40
126	"	10:30:00	10:32:08
127	"	10:32:38	10:34:40
128	"	11:02:00	11:04:08
129	"	11:04:38	11:06:40
130	"	11:30:00	11:32:08
131	"	11:32:38	11:34:40
132	"	12:00:00	12:02:08
133	"	12:02:38	12:04:41
134	"	13:03:00	13:05:09
135	"	13:05:39	13:07:41

Table 3 (cont.)

Profile #	Date	Time Start (EST)	Time Stop (EST)
136	1/29/80	14:00:00	14:02:13
137	"	14:02:43	14:04:45
138	"	15:00:12	15:02:23
139	"	15:02:53	15:04:56
140	"	16:00:07	16:02:16
141	"	16:02:46	16:04:48
142	"	17:00:00	17:02:13
143	"	07:28:00	07:30:03
144	"	07:33:00	07:35:13
145	"	07:35:43	07:37:44
146	"	08:00:00	08:02:09
147	"	08:02:39	08:04:41
148	"	08:30:00	08:32:14
149	"	08:32:44	08:34:50
150	"	09:00:00	09:02:15
151	"	09:02:45	09:04:51
152	"	09:35:00	09:37:24
153	"	09:37:54	09:39:57
154	"	10:00:00	10:02:12
155	"	10:02:42	10:04:44
156	"	10:30:00	10:32:20
157	"	10:32:50	10:34:52
158	"	11:00:00	11:02:10
159	"	11:02:40	11:04:42
160	"	11:30:00	11:32:12
161	"	11:32:42	11:33:11
162	"	12:00:00	12:02:17
163	"	12:02:47	12:04:50
164	"	12:30:00	12:32:12
165	"	12:32:42	12:34:54
166	"	13:00:00	13:02:10
167	"	13:02:40	13:04:42
168	"	13:30:00	13:32:11
169	"	13:32:41	13:34:44
170	"	14:00:00	14:02:10
171	"	14:02:40	14:04:44
172	"	14:30:00	14:32:12
173	"	14:32:42	14:34:44
174	"	15:00:00	15:02:09
175	"	15:02:39	15:04:46
176	"	15:30:00	15:32:08
177	"	15:32:38	15:34:41
178	"	16:00:00	16:02:09
179	"	16:02:39	16:04:42
180	"	16:30:00	16:32:11
181	"	16:32:41	16:34:44
182	"	17:00:00	17:02:09

Table 3 (cont.)

Profile #	Date	Time Start (EST)	Time Stop (EST)
183	2/1/80	07:59:00	08:01:23
184	"	08:04:00	08:06:43
185	"	08:07:13	08:09:20
186	"	09:00:00	09:02:27
187	"	09:02:47	09:03:18
188	"	09:44:39	09:46:52
189	"	17:01:00	17:04:02
190	2/2/80	09:38:06	09:40:02
191	"	14:05:42	14:07:39
192	"	15:00:00	15:02:22
193	"	15:02:42	15:04:46
194	"	16:00:00	16:02:23
195	"	16:02:43	16:04:47
196	"	17:00:00	17:02:14
197	2/3/80	11:04:00	11:06:17
198	"	11:06:47	11:08:52
199	"	11:30:00	11:32:18
200	"	11:32:48	11:34:51
201	"	12:00:00	12:02:22
202	"	12:02:52	12:04:56
203	"	12:30:00	12:32:17
204	"	12:32:42	12:34:50
205	"	13:00:00	13:02:19
206	"	13:02:49	13:04:51
207	"	14:02:00	14:04:16
208	"	14:04:46	14:06:51
209	"	14:30:00	14:32:19
210	"	14:32:39	14:34:54
211	"	15:00:00	15:02:17
212	"	15:02:47	15:04:51
213	"	15:30:00	15:32:25
214	"	15:32:55	15:34:59
215	"	16:00:00	16:02:16
216	"	16:02:46	16:04:50
217	"	16:30:00	16:32:17
218	"	16:32:47	16:34:52
219	"	17:00:00	17:02:25
220	2/4/80	09:30:00	09:32:14
221	"	09:32:44	09:34:48
222	"	10:00:00	10:02:15
223	"	10:02:45	10:04:49
224	"	11:35:00	11:37:17
225	"	11:37:47	11:39:51
226	"	12:00:00	12:02:13
227	"	12:02:43	12:04:48
228	"	14:30:00	14:32:15

Table 3 (cont.)

Profile #	Date	Time Start (EST)	Time Stop (EST)
229	2/4/80	14:32:45	14:34:50
230	"	15:00:00	15:02:27
231	"	15:02:57	15:05:05
232	"	15:30:00	15:32:30
233	"	15:33:00	15:35:05
234	"	16:00:00	16:02:26
235	"	16:02:56	16:05:00
236	"	16:30:00	16:32:30
237	"	16:33:00	16:35:08
238	"	17:00:00	17:02:38
239	2/5/80	10:00:00	10:02:08
240	"	10:02:38	10:04:43
241	"	10:30:00	10:32:13
242	"	10:32:43	10:34:47
243	"	11:00:00	11:02:13
244	"	11:02:43	11:04:46
245	"	11:30:00	11:32:26
246	"	11:32:56	11:35:00
247	"	12:00:00	12:02:18
248	"	12:02:48	12:04:56
249	"	12:30:00	12:32:15
250	"	12:32:45	12:34:49
251	"	15:03:00	15:04:56
252	"	15:18:00	15:20:17
253	"	15:20:47	15:22:45
254	"	15:27:00	15:29:14
255	"	15:29:44	15:31:39
256	"	15:42:00	15:44:08
257	"	15:44:38	15:46:36
258	"	15:51:00	15:53:12
259	"	15:53:42	15:55:37
260	"	16:00:00	16:02:10
261	"	16:02:45	16:04:41
262	"	16:10:00	16:12:13
263	"	16:12:43	16:14:39
264	"	16:19:00	16:21:18
265	"	16:21:48	16:23:43
266	"	16:28:00	16:30:26
267	"	16:30:56	16:32:52
268	"	16:38:00	16:40:30

Figure 6a. Tethered balloon profiles of wind speed (S), wind direction (Ð) and temperature (·) from surface to 150 m on 29 January 1980 at 0735 EST.

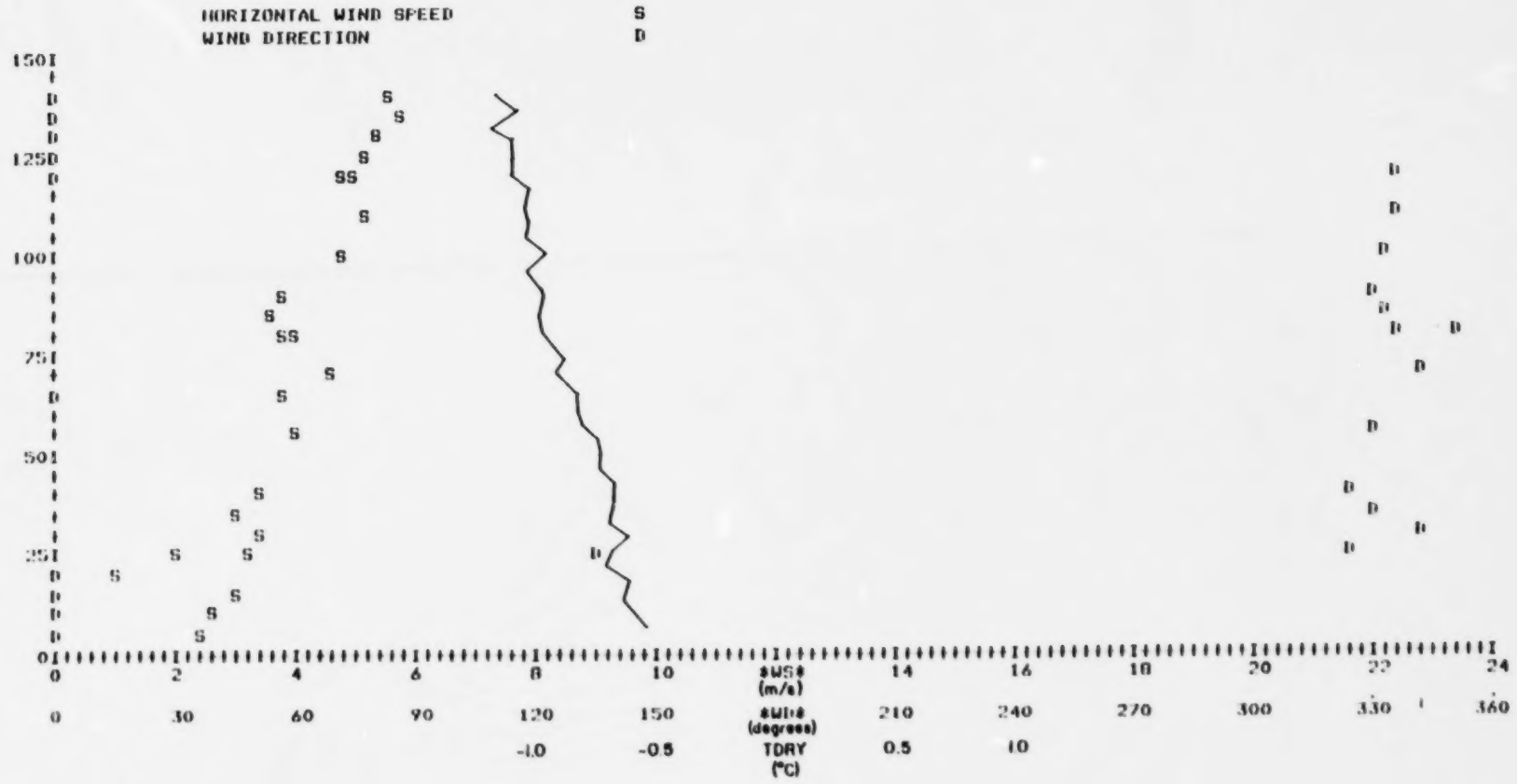


Figure 6b. Same as Figure 6a except at 0835 EST.

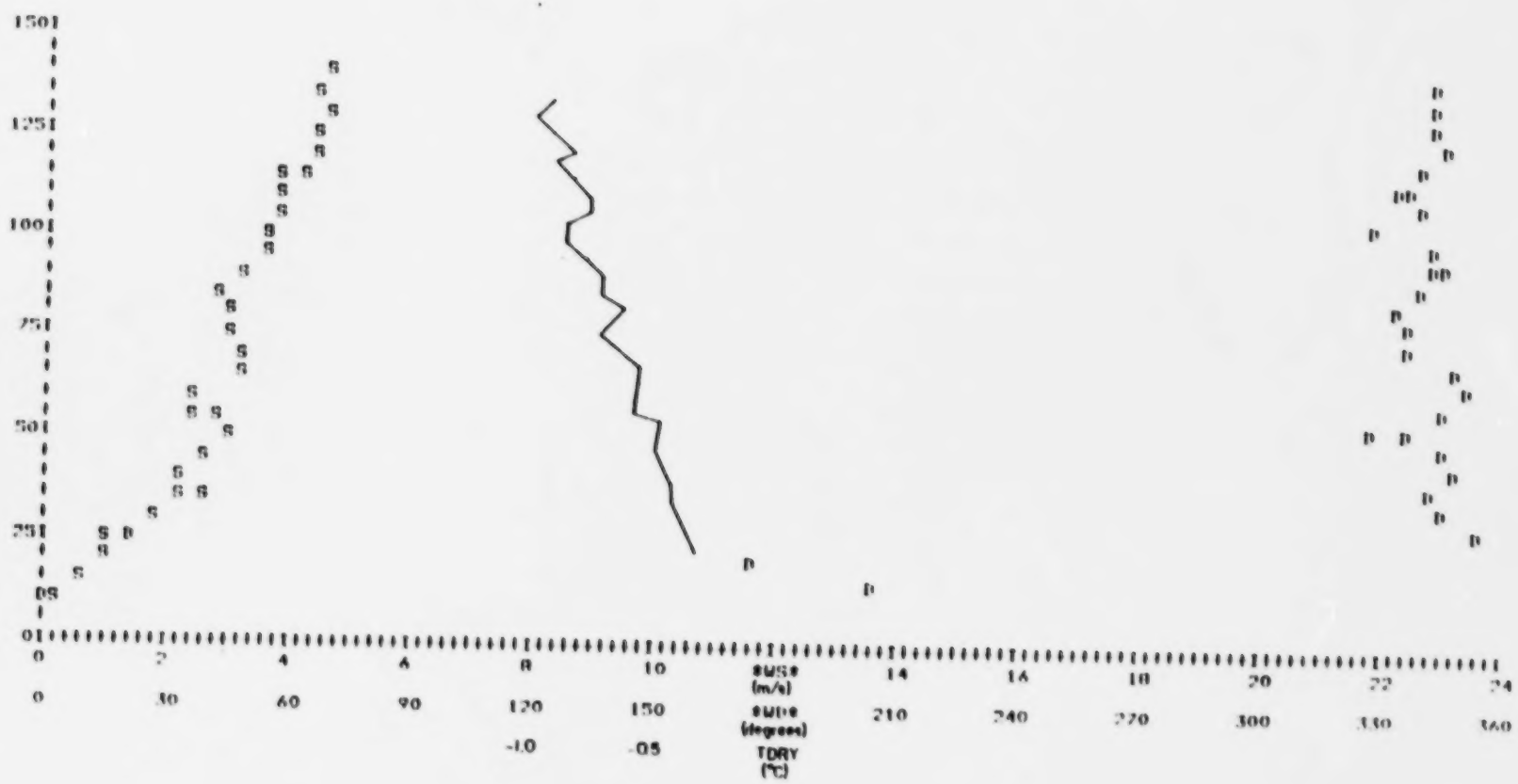


Figure 6c. Same as Figure 6a except at 0930 EST.

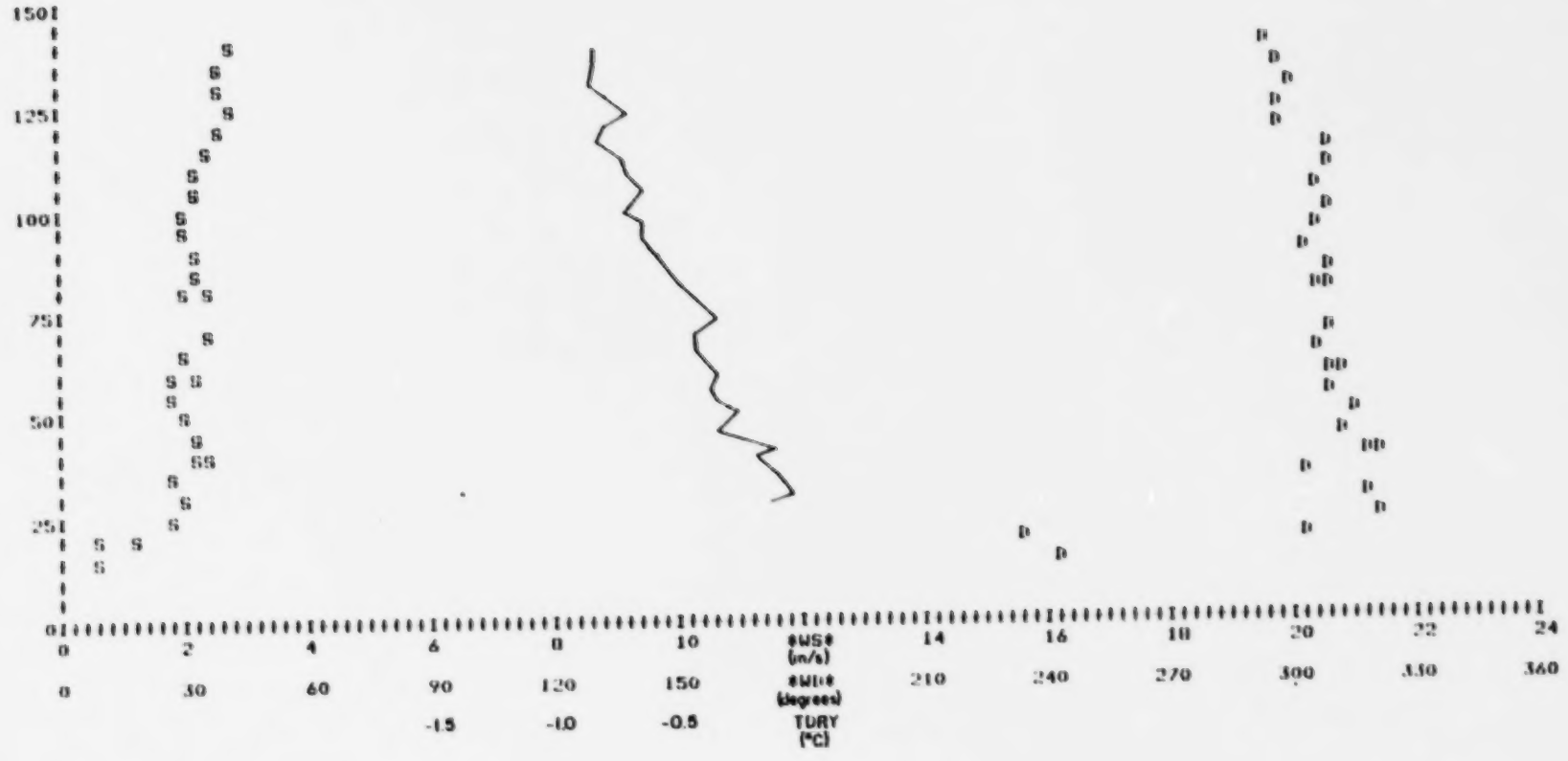


Table 4. Summary of kite soundings made by station (see Figure 2) from surface to approximately 100 m with the number of levels at which readings were taken indicated for each sounding.

Station No.	Station Name	Date	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels
10	Smith Island	1/24/80	07:43	8	08:12	10	09:58	11	11:00	11	12:00	11
12	Deal Island	"	08:02	11	09:01	11	10:01	11	11:02	11	12:01	11
31	Crisfield	"	07:30	8	09:07	8	ND	--	10:30	8	12:02	8
32	Kingston	"	ND	--	08:20	8	09:45	8	11:15	8	ND	--
33	Princess Anne	"	07:48	4	08:30	3	10:00	9	11:00	10	12:00	9
41	Saxis	"	08:11	9	09:00	10	10:00	11	11:00	11	12:00	11
42	Pocomoke City	"	ND	--	09:10	8	ND	--	10:45	8	ND	--
52	Oak Hall	"	ND	--	08:26	8	10:02	8	11:36	8	13:12	8
71	Assateague So.	"	07:35	7	08:14	10	10:00	10	11:00	10	12:00	10
72	Assateague No.	"	07:33	8	09:00	11	ND	--	ND	--	12:00	6
10	Smith Island	1/25/80	ND	--	ND	--	ND	--	10:45	2	11:30	3
12	Deal Island	"	08:03	6	ND	--	ND	--	ND	--	12:16	1
31	Crisfield	"	ND	--	ND	--	ND	--	ND	--	11:30	7
32	Kingston	"	ND	--	ND	--	ND	--	ND	--	ND	--
33	Princess Anne	"	08:10	2	ND	--	ND	--	ND	--	ND	--
41	Saxis	"	08:15	1	08:30	5	09:30	6	11:30	11	12:30	11
42	Pocomoke City	"	ND	--	ND	--	ND	--	ND	--	ND	--
52	Oak Hall	"	ND	--	ND	--	ND	--	ND	--	ND	--
71	Assateague So.	"	ND	--	09:25	1	09:30	11	ND	--	ND	--
72	Assateague No.	"	ND	--	ND	--	ND	--	ND	--	11:41	5
10	Smith Island	1/26/80	07:30	9	08:30	9	09:31	9	10:30	6	ND	--
12	Deal Island	"	07:31	11	08:31	3	ND	--	ND	--	12:16	1
31	Crisfield	"	07:30	7	ND	--	09:33	6	11:32	5	ND	--
32	Kingston	"	ND	--	ND	--	ND	--	ND	--	ND	--
33	Princess Anne	"	ND	--	ND	--	ND	--	ND	--	ND	--
41	Saxis	"	07:30	9	08:30	3	09:32	6	10:30	9	12:05	2
42	Pocomoke City	"	ND	--	ND	--	09:35	5	ND	--	11:42	5
52	Oak Hall	"	ND	--	ND	--	ND	--	10:33	8	ND	--
71	Assateague So.	"	07:35	11	08:30	11	09:30	11	10:30	11	11:30	5
72	Assateague No.	"	07:30	11	08:30	11	09:30	11	10:30	11	11:30	8

Table 4 (cont.)

Station No.	Station Name	Date	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels
10	Smith Island	1/24/80	13:00	11	14:02	10	15:02	7	ND	--	ND	--
12	Deal Island	"	13:00	11	14:01	11	15:01	11	16:00	11	17:01	7
31	Crisfield	"	ND	--	13:25	8	ND	--	ND	--	16:30	8
32	Kingston	"	12:52	6	ND	--	ND	--	ND	--	ND	--
33	Princess Anne	"	13:07	9	14:03	9	15:00	4	ND	--	ND	--
41	Saxis	"	13:00	11	14:00	11	15:00	11	16:00	11	17:00	5
42	Pocomoke City	"	12:25	8	13:54	5	ND	--	15:33	5	ND	--
52	Oak Hall	"	13:12	8	ND	--	14:47	8	ND	--	ND	--
71	Assateague So.	"	13:00	10	14:00	10	15:00	10	16:00	10	17:00	9
72	Assateague No.	"	13:00	5	14:00	5	15:00	5	16:00	6	ND	--
10	Smith Island	1/25/80	12:30	8	13:30	11	14:30	11	15:29	8	ND	--
12	Deal Island	"	12:31	2	13:36	10	14:31	3	ND	--	ND	--
31	Crisfield	"	ND	--	13:30	8	ND	--	ND	--	ND	--
32	Kingston	"	ND	--	ND	--	ND	--	ND	--	ND	--
33	Princess Anne	"	ND	--	ND	--	ND	--	ND	--	ND	--
41	Saxis	"	12:30	11	13:30	11	14:30	11	15:30	6	16:30	6
42	Pocomoke City	"	ND	--	13:30	6	ND	--	ND	--	ND	--
52	Oak Hall	"	12:37	8	ND	--	14:43	7	ND	--	ND	--
71	Assateague So.	"	12:32	6	13:30	10	14:32	10	15:39	2	ND	--
72	Assateague No.	"	12:30	7	13:30	6	ND	--	ND	--	ND	--
10	Smith Island	1/26/80	12:34	1	ND	--	ND	--	ND	--	ND	--
12	Deal Island	"	12:30	11	13:42	8	14:31	6	15:31	10	16:34	8
31	Crisfield	"	ND	--	13:43	5	ND	--	15:30	8	ND	--
32	Kingston	"	12:35	8	ND	--	14:30	8	ND	--	ND	--
33	Princess Anne	"	12:30	4	ND	--	14:45	3	15:30	5	16:30	6
41	Saxis	"	12:30	7	13:30	11	14:30	11	15:30	11	16:30	8
42	Pocomoke City	"	ND	--	13:36	6	ND	--	15:30	5	ND	--
52	Oak Hall	"	12:33	8	ND	--	14:30	8	ND	--	16:32	6
71	Assateague So.	"	ND	--	13:30	11	14:30	11	15:30	11	16:30	8
72	Assateague No.	"	ND	--	14:10	2	14:30	11	15:30	11	16:30	8

Table 4 (cont.)

Station No.	Station Name	Date	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels
10	Smith Island	1/28/80	07:31	10	08:30	10	09:32	10	10:32	10	11:32	10
12	Deal Island	"	07:34	11	08:31	11	09:31	11	10:31	11	11:31	11
13	Nanticoke	"	07:46	7	08:31	11	09:31	11	10:30	11	11:30	11
31	Crisfield	"	07:30	7	ND	--	09:30	8	ND	--	11:30	8
32	Kingston	"	ND	--	ND	--	ND	--	10:30	8	ND	--
33	Princess Anne	"	ND	--	08:45	3	09:31	7	10:31	7	11:30	9
41	Saxis	"	07:30	11	08:30	11	09:30	11	10:30	11	11:30	11
42	Pocomoke City	"	ND	--	ND	--	09:33	6	ND	--	11:30	8
52	Oak Hall	"	ND	--	ND	--	ND	--	10:30	8	ND	--
71	Assateague So.	"	07:30	11	08:31	11	09:30	11	10:30	11	11:30	11
72	Assateague No.	"	07:32	10	08:30	10	09:30	10	10:30	11	11:30	9
10	Smith Island	1/29/80	07:35	8	08:30	8	09:31	8	10:30	10	11:32	8
12	Deal Island	"	07:30	10	08:30	4	10:05	2	10:33	4	12:24	1
13	Nanticoke	"	07:30	11	08:30	6	ND	--	ND	--	11:30	2
31	Crisfield	"	07:55	5	ND	--	09:31	7	ND	--	11:29	6
32	Kingston	"	ND	--	ND	--	ND	--	ND	--	ND	--
33	Princess Anne	"	ND	--	ND	--	10:00	2	10:30	2	ND	--
41	Saxis	"	07:30	10	08:30	9	09:30	8	11:00	2	11:30	11
42	Pocomoke City	"	ND	--	ND	--	ND	--	ND	--	11:27	8
52	Oak Hall	"	ND	--	ND	--	ND	--	ND	--	ND	--
71	Assateague So.	"	07:32	11	08:30	--	09:30	11	10:30	11	11:30	11
72	Assateague No.	"	ND	--	ND	--	ND	--	10:30	11	11:30	10
10	Smith Island	1/30/80	ND	--	ND	--	ND	--	ND	--	11:32	10
12	Deal Island	"	07:32	6	08:32	7	ND	--	ND	--	ND	--
13	Nanticoke	"	07:30	10	08:30	11	09:30	11	10:30	11	11:30	11
31	Crisfield	"	07:33	8	ND	--	09:30	8	ND	--	11:33	8
32	Kingston	"	ND	--	08:35	8	ND	--	10:33	8	ND	--
33	Princess Anne	"	ND	--	08:30	9	09:30	9	10:30	8	11:30	9
41	Saxis	"	07:30	7	08:30	11	09:30	11	10:30	11	11:30	11
42	Pocomoke City	"	07:34	8	ND	--	09:30	8	ND	--	11:30	9
52	Oak Hall	"	ND	--	08:35	9	ND	--	10:30	9	ND	--
71	Assateague So.	"	07:42	11	08:30	11	09:30	11	10:30	11	11:30	11
72	Assateague No.	"	07:35	11	08:30	11	09:30	11	10:30	11	11:30	9

Table 4 (cont.)

Station No.	Station Name	Date	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels
10	Smith Island	1/28/80	12:30	8	13:31	11	14:30	11	15:31	11	16:25	8
12	Deal Island	"	12:31	11	13:31	11	14:31	11	15:31	11	16:31	8
13	Hanticoke	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	10
31	Crisfield	"	ND	--	13:32	8	ND	--	15:35	8	ND	--
32	Kingston	"	12:30	8	ND	--	14:33	7	ND	--	16:30	8
33	Princess Anne	"	12:30	9	13:30	9	14:30	10	15:30	10	16:30	7
41	Saxis	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	11
42	Pocomoke City	"	ND	--	13:30	8	ND	--	15:34	8	ND	--
52	Oak Hall	"	12:33	8	ND	--	14:30	8	ND	--	16:30	8
71	Assateague So.	"	12:30	11	13:32	11	14:30	11	15:32	11	16:31	11
72	Assateague No.	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	8
10	Smith Island	1/29/80	12:35	7	13:32	9	14:32	10	15:31	10	16:32	8
12	Deal Island	"	12:32	11	13:31	11	14:31	11	15:31	11	16:32	8
13	Hanticoke	"	12:30	11	13:30	9	14:30	11	15:30	11	16:30	11
31	Crisfield	"	ND	--	13:30	8	ND	--	15:32	8	ND	--
32	Kingston	"	12:35	8	ND	--	14:30	8	ND	--	16:34	8
33	Princess Anne	"	12:45	3	13:30	7	ND	--	ND	--	ND	--
41	Saxis	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	8
42	Pocomoke City	"	ND	--	13:31	8	ND	--	15:32	8	ND	--
52	Oak Hall	"	12:32	8	ND	--	14:30	8	ND	--	16:34	8
71	Assateague So.	"	12:30	11	13:30	11	14:32	11	15:30	11	16:30	8
72	Assateague No.	"	12:30	8	13:30	8	14:30	10	15:30	11	16:30	8
10	Smith Island	1/30/80	12:31	10	13:30	10	14:30	10	15:32	9	16:32	8
12	Deal Island	"	ND	--	14:20	1	14:31	11	15:31	11	16:31	8
13	Hanticoke	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	11
31	Crisfield	"	ND	--	13:30	8	ND	--	15:30	8	ND	--
32	Kingston	"	12:33	8	ND	--	14:30	8	ND	--	16:30	8
33	Princess Anne	"	12:30	9	13:30	9	14:30	9	15:30	9	16:30	8
41	Saxis	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	8
42	Pocomoke City	"	ND	--	13:30	9	ND	--	15:30	8	ND	--
52	Oak Hall	"	12:30	11	ND	--	14:30	8	16:30	9	ND	--
71	Assateague So.	"	12:31	11	13:30	11	14:30	11	15:31	11	16:31	8
72	Assateague No.	"	12:30	10	13:30	9	14:30	10	15:30	6	ND	--

Table 4 (cont.)

Station No.	Station Name	Date	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels
10	Smith Island	2/1/80	08:00	6	ND	--	ND	--	ND	--	ND	--
12	Deal Island	"	ND	--	ND	--	ND	--	ND	--	ND	--
13	Nanticoke	"	ND	--	ND	--	ND	--	ND	--	ND	--
31	Crisfield	"	08:05	8	ND	--	10:00	7	ND	--	ND	--
32	Kingston	"	ND	--	09:00	8	ND	--	11:00	8	ND	--
33	Princess Anne	"	08:30	2	09:00	4	10:00	8	11:00	9	12:00	7
41	Saxis	"	ND	--	ND	--	ND	--	ND	--	12:00	8
42	Pocomoke City	"	08:00	9	ND	--	10:03	11	ND	--	12:00	11
52	Oak Hall	"	ND	--	09:02	8	ND	--	11:03	11	ND	--
71	Assateague So.	"	ND	--	09:37	2	10:00	4	11:00	9	12:00	9
72	Assateague No.	"	07:55	11	09:00	11	10:07	11	11:05	11	12:00	11
10	Smith Island	2/2/80	ND	--	ND	--	ND	--	ND	--	ND	--
12	Deal Island	"	07:32	10	08:31	9	09:31	4	10:31	4	11:31	9
13	Nanticoke	"	07:30	1	08:30	4	09:30	4	10:30	4	11:30	4
31	Crisfield	"	ND	--	ND	--	ND	--	ND	--	ND	--
32	Kingston	"	ND	--	ND	--	ND	--	ND	--	ND	--
33	Princess Anne	"	07:35	8	08:30	8	09:30	8	10:30	8	11:30	8
41	Saxis	"	07:30	11	08:30	4	ND	--	10:52	3	11:30	4
42	Pocomoke City	"	07:45	8	ND	--	09:35	8	ND	--	11:37	8
52	Oak Hall	"	ND	--	08:35	11	ND	--	10:37	8	ND	--
71	Assateague So.	"	07:38	11	08:30	11	09:32	11	10:30	11	11:30	11
72	Assateague No.	"	07:45	2	ND	--	ND	--	ND	--	ND	--
10	Smith Island	2/3/80	ND	--	ND	--	ND	--	ND	--	ND	--
12	Deal Island	"	07:31	11	08:30	11	09:31	11	10:30	10	11:30	11
13	Nanticoke	"	07:31	11	08:30	11	09:30	11	10:30	11	11:30	11
31	Crisfield	"	07:30	6	ND	--	09:30	7	ND	--	11:30	7
32	Kingston	"	ND	--	08:30	7	ND	--	10:30	7	ND	--
33	Princess Anne	"	ND	--	ND	--	ND	--	ND	--	ND	--
41	Saxis	"	07:30	11	08:30	11	09:30	11	10:30	11	11:30	11
42	Pocomoke City	"	07:30	8	ND	--	09:36	8	ND	--	11:34	8
52	Oak Hall	"	ND	--	08:48	8	ND	--	10:32	11	ND	--
71	Assateague So.	"	07:35	11	08:29	11	09:30	11	10:34	11	11:30	11
72	Assateague No.	"	07:30	9	08:30	10	09:30	10	10:30	10	11:39	9

Table 4 (cont.)

Station No.	Station Name	Date	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels
10	Smith Island	2/1/80	ND	--	ND	--	ND	--	ND	--	ND	--
12	Deal Island	"	ND	--	ND	--	ND	--	ND	--	ND	--
13	Nanticoke	"	ND	--	ND	--	ND	--	ND	--	ND	--
31	Crisfield	"	ND	--	ND	--	ND	--	ND	--	ND	--
32	Kingston	"	ND	--	ND	--	ND	--	ND	--	ND	--
33	Princess Anne	"	13:00	8	14:00	8	15:00	9	16:00	6	ND	--
41	Saxis	"	13:00	9	14:00	10	15:00	8	16:00	8	ND	--
42	Pocomoke City	"	ND	--	14:04	11	ND	--	16:03	11	ND	--
52	Oak Hall	"	13:00	8	ND	--	15:00	11	ND	--	ND	--
71	Assateague So.	"	13:00	9	14:00	7	15:00	8	16:00	6	ND	--
72	Assateague No.	"	13:00	11	14:04	11	15:03	8	16:01	8	ND	--
10	Smith Island	2/2/80	ND	--	ND	--	ND	--	ND	--	ND	--
12	Deal Island	"	12:30	9	13:31	11	14:30	11	15:31	11	16:30	8
13	Nanticoke	"	12:30	4	13:30	10	14:30	10	15:30	11	16:30	8
31	Crisfield	"	ND	--	ND	--	ND	--	ND	--	ND	--
32	Kingston	"	ND	--	ND	--	ND	--	ND	--	ND	--
33	Princess Anne	"	12:30	8	13:30	9	14:30	8	15:30	9	16:30	6
41	Saxis	"	12:30	4	13:30	11	14:30	11	15:30	11	16:30	8
42	Pocomoke City	"	ND	--	13:38	8	ND	--	15:35	8	ND	--
52	Oak Hall	"	12:37	8	ND	--	14:33	11	ND	--	16:31	8
71	Assateague So.	"	12:30	11	13:34	11	14:32	11	15:33	11	16:30	8
72	Assateague No.	"	ND	--	ND	--	ND	--	ND	--	ND	--
10	Smith Island	2/3/80	12:34	9	13:30	11	14:30	11	15:31	11	16:31	8
12	Deal Island	"	12:30	11	13:31	11	14:30	11	15:30	11	16:31	8
13	Nanticoke	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	8
31	Crisfield	"	ND	--	13:30	7	ND	--	15:30	7	ND	--
32	Kingston	"	12:30	7	ND	--	14:30	7	ND	--	16:30	7
33	Princess Anne	"	ND	--	ND	--	ND	--	ND	--	ND	--
41	Saxis	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	8
42	PocomokeCCity	"	ND	--	13:31	8	ND	--	15:36	--	ND	--
52	Oak Hall	"	12:34	8	ND	--	14:32	11	ND	--	16:32	8
71	Assateague So.	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	8
72	Assateague No.	"	12:30	10	13:30	10	14:30	10	15:30	10	16:30	7

Table 4 (cont.)

Station No.	Station Name	Date	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels
10	Smith Island	2/4/80	07:32	10	08:31	10	09:32	8	ND	--	ND	--
12	Deal Island	"	07:30	10	08:30	10	09:30	11	10:30	11	11:30	11
13	Hanticoke	"	07:33	10	08:30	10	09:30	10	10:30	10	11:30	10
31	Crisfield	"	07:30	7	ND	--	09:30	7	ND	--	11:30	7
32	Kingston	"	ND	--	08:30	7	ND	--	10:30	7	ND	--
33	Princess Anne	"	ND	--	ND	--	ND	--	ND	--	ND	--
41	Saxis	"	07:33	10	08:30	10	09:30	10	10:30	10	11:30	10
42	Pocomoke City	"	07:41	5	ND	--	09:30	7	ND	--	11:30	10
52	Oak Hall	"	ND	--	08:30	7	ND	--	10:33	7	ND	--
71	Assateague So.	"	07:40	10	08:32	10	09:34	10	10:34	10	11:30	9
72	Assateague No.	"	07:30	10	08:30	9	09:30	10	10:30	10	11:30	10
10	Smith Island	2/5/80	ND	--	ND	--	ND	--	ND	--	ND	--
12	Deal Island	"	07:31	11	08:31	11	09:30	11	10:31	11	11:30	8
13	Hanticoke	"	07:30	10	08:30	10	09:30	10	10:30	10	11:30	8
31	Crisfield	"	07:30	7	ND	--	09:30	7	ND	--	11:30	7
32	Kingston	"	ND	--	08:30	7	ND	--	10:30	7	ND	--
33	Princess Anne	"	ND	--	ND	--	ND	--	ND	--	ND	--
41	Saxis	"	07:30	10	08:30	10	09:30	10	10:30	10	11:30	7
42	Pocomoke City	"	07:30	6	ND	--	09:33	9	ND	--	11:31	7
52	Oak Hall	"	ND	--	08:30	9	ND	--	10:32	9	ND	--
71	Assateague So.	"	07:31	10	08:32	10	09:30	10	10:30	10	11:35	7
72	Assateague No.	"	07:38	10	08:30	10	09:30	10	10:30	10	11:30	7

Table 4 (cont.)

Station No.	Station Name	Date	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels	Profile (EST)	No. of Levels
10	Smith Island	2/4/80	ND	--	ND	--	14:45	10	15:28	10	16:30	8
12	Deal Island	"	12:30	11	13:30	11	14:30	11	15:30	11	16:30	8
13	Nanticoke	"	12:30	10	13:30	10	14:30	10	15:30	10	16:30	8
31	Crisfield	"	ND	--	13:30	7	ND	--	15:30	7	ND	--
32	Kingston	"	12:30	7	ND	--	14:30	7	ND	--	16:30	7
33	Princess Anne	"	ND	--	ND	--	ND	--	ND	--	ND	--
41	Saxis	"	12:30	10	13:30	10	14:30	10	15:30	10	16:30	7
42	Pocomoke City	"	ND	--	13:32	11	ND	--	15:31	10	ND	--
52	Oak Hall	"	12:32	7	ND		14:31	7	ND	--	16:30	10
71	Assateague So.	"	12:40	10	13:34	10	14:32	10	15:34	10	16:30	7
72	Assateague No.	"	12:30	10	13:30	9	14:30	10	15:30	9	16:29	7

) DATA FROM 12:30 ON FOR 2/5/80

Figure 7a. Kite soundings of wind speed and di tion at Assateague North (Site 72) on 29 January 1980 at 0745 EST.

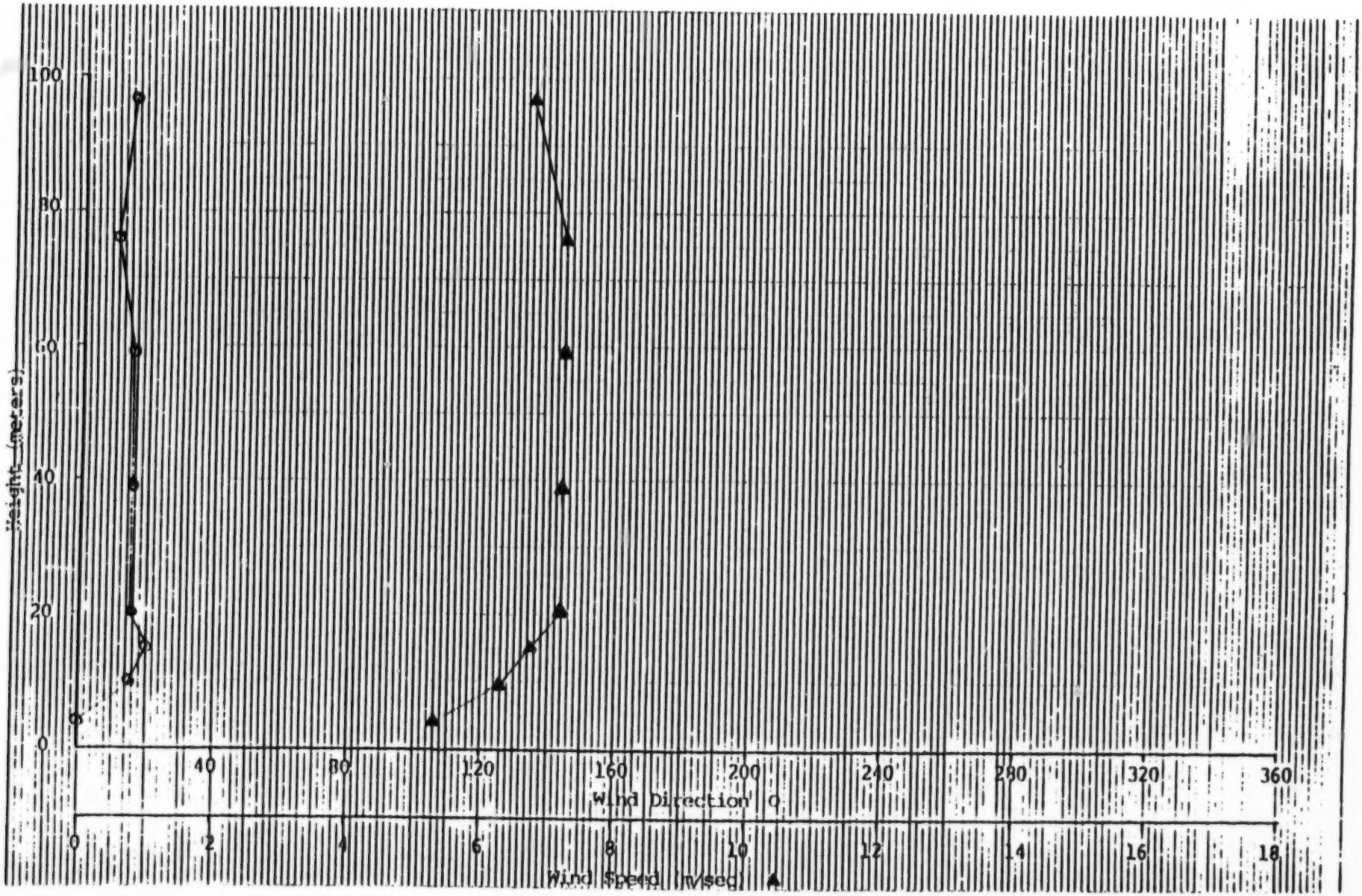


Figure 7b. Same as Figure 7a except at 0830 EST.

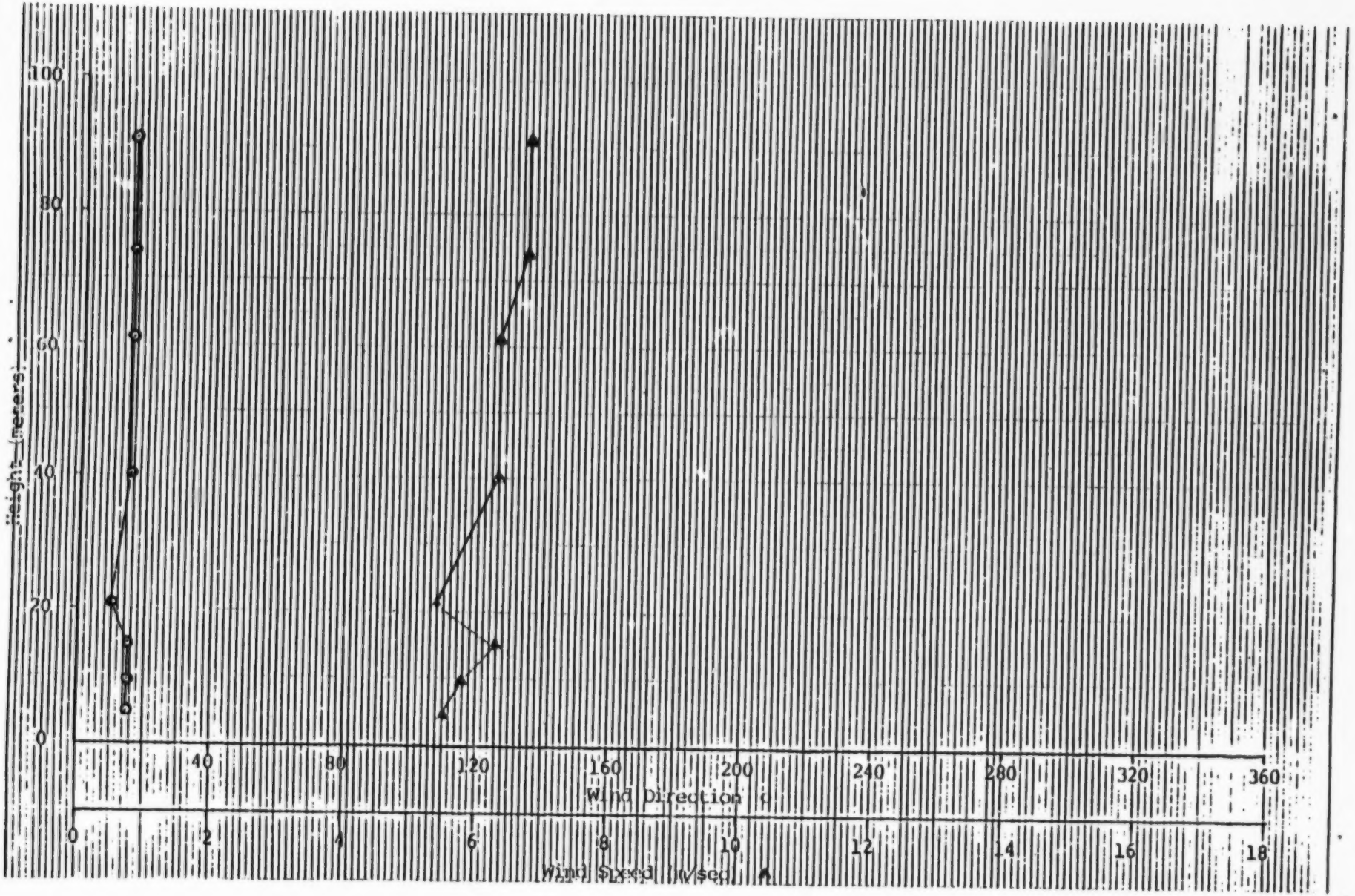


Figure 7c. Same as Figure 7a except at 0930 EST.

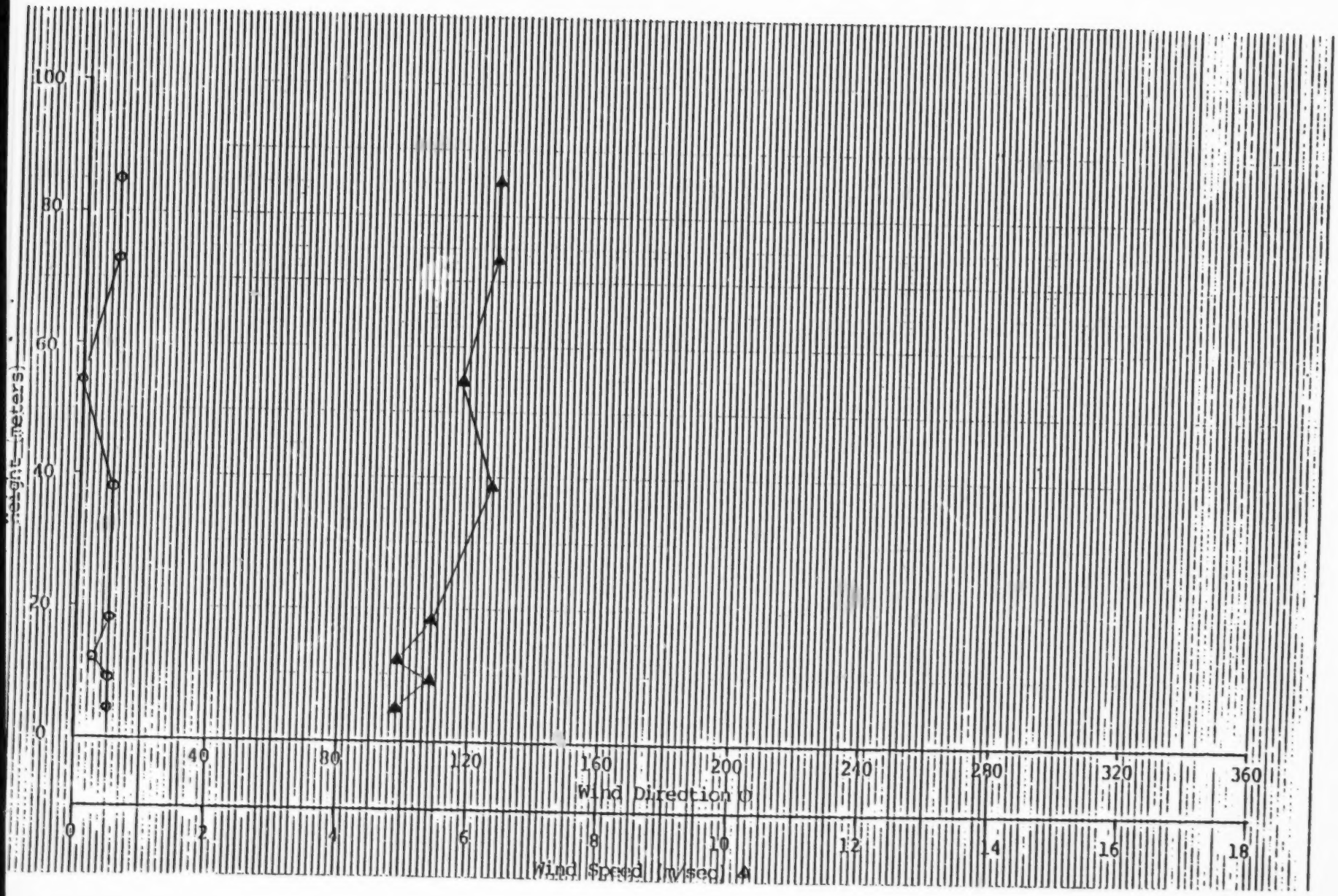


Figure 8a. Profiles of 5 minute average wind speed and direction from the 300 ft NASA Wallops Flight Facility tower on 29 January 1980 at 0734 EST.

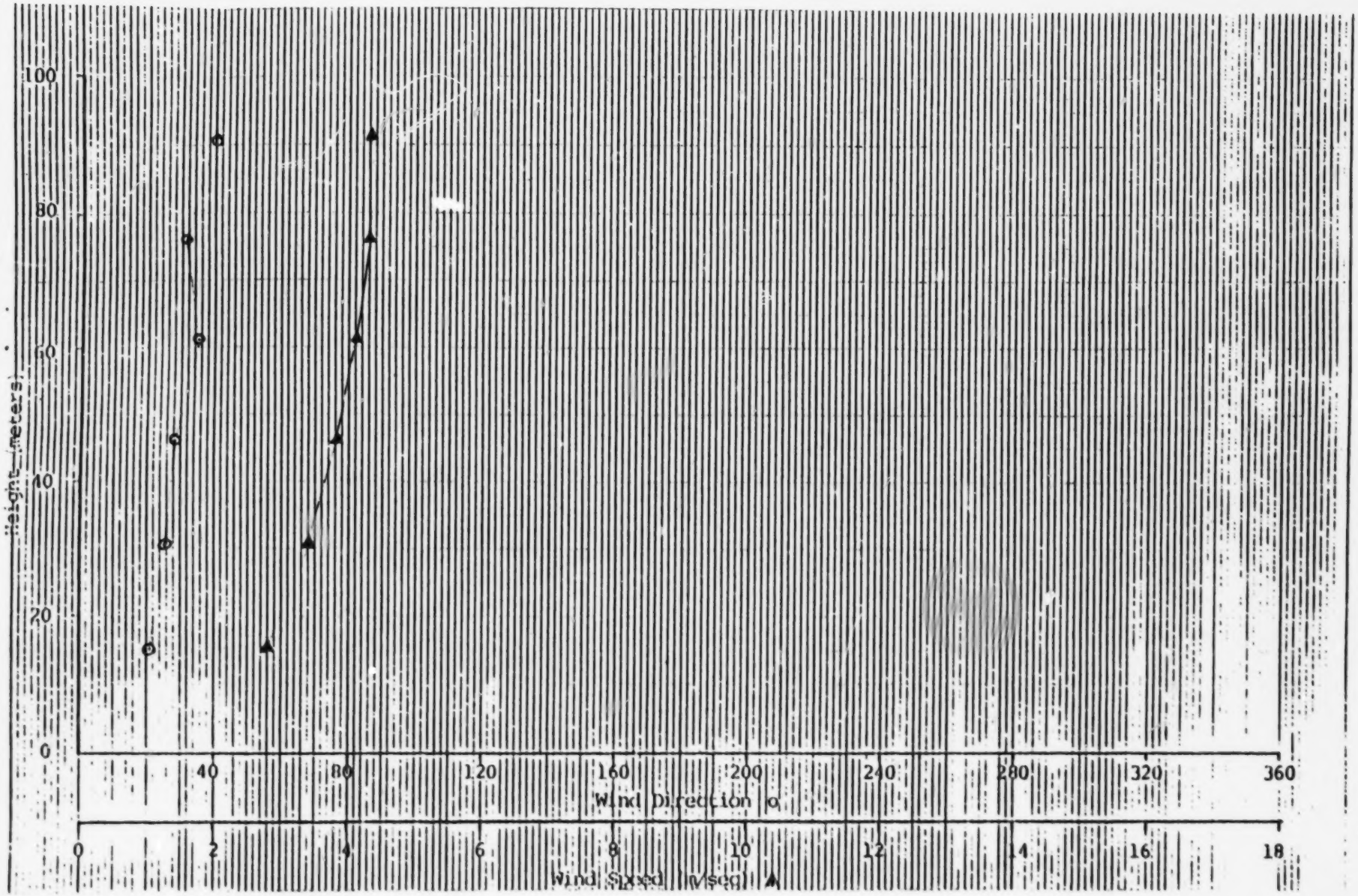


Figure 8b. Same as Figure 8a except at 0830 EST.

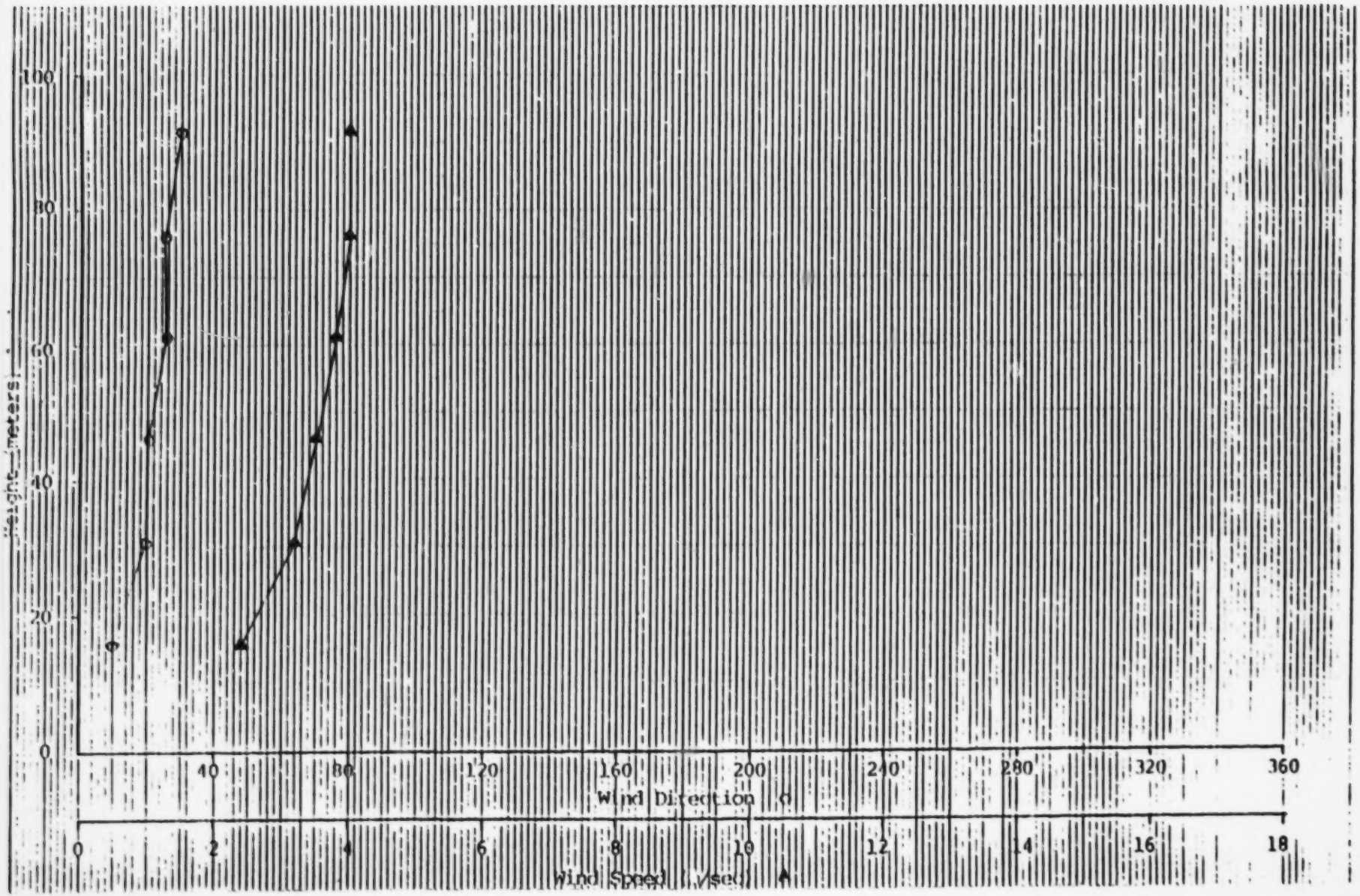


Figure 8c. Same as Figure 8a except at 0929 EST.

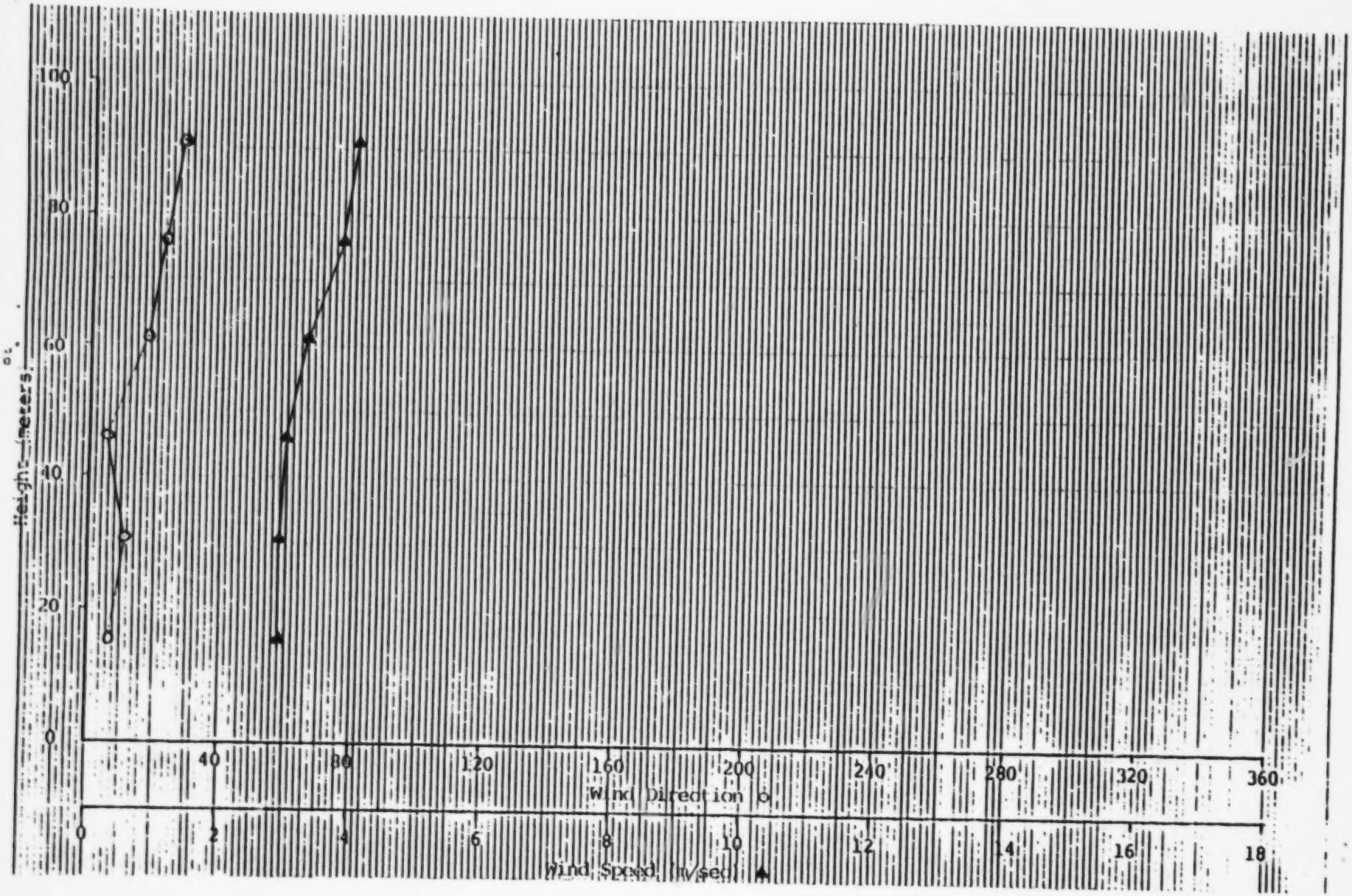


Table 5. Comparison between tower measured (site 61), kite measured (site 72) and tethered balloon (site 63) measured winds on the morning of 29 January 1980.

Tower (site 61)				Kite (site 72)				Tethered balloon (site 63)			
Z Meters	U m/sec	Dir. degree	Time	Time	Z Meters	U m/sec	Dir. degree	Time	Z Meters	U m/sec	Dir. degree
			0734	0756	4.1	5.4	0.0				
					9.6	6.3	15.0		10.0	2.6	360
15.24	2.8	21.4			15.0	6.7	20.0		15.0	3.0	330
45.72	3.8	28.0			39.3	7.2	15.0		40.0	3.4	326
60.96	4.1	35.0			58.9	7.2	15.0		60.0	4.0	333
76.20	4.3	31.2			75.7	7.2	10.0		75.0	4.1	342
91.44	4.3	40.6		0745	96.4	6.7	15.0	0735	90.0	3.8	330
			0834	0844	4.4	5.4	15.0				
					9.6	5.8	15.0		10.0	0.2	010
15.24	2.4	10.4			14.7	6.3	15.0		15.0	0.6	204
30.48	3.2	15.4			20.7	5.4	10.0		30.0	1.8	355
45.72	3.5	20.2			40.0	6.3	15.0		40.0	2.5	340
60.96	3.8	25.2			61.0	6.3	15.0		60.0	2.9	340
76.20	4.0	25.4			74.2	6.7	15.0		75.0	3.1	336
91.44	4.0	29.8		0830	90.9	6.7	15.0	0834	90.0	3.4	340
			0929	0944	4.5	4.9	10.0				
					9.1	5.4	10.0		10.0	---	---
15.24	2.9	6.8			12.2	4.9	5.0		15.0	0.6	243
30.48	2.9	11.4			18.2	5.4	10.0		30.0	2.0	317
45.72	3.0	5.2			38.6	6.3	10.0		40.0	2.3	318
60.96	3.3	16.8			54.5	5.8	0.0		60.0	2.1	311
76.20	3.8	22.2			72.7	6.3	10.0		75.0	2.2	308
91.44	4.0	27.6		0930	85.1	6.3	10.0	0930	90.0	2.2	305

All rawind soundings made at Wallops Island (2/day), were collected together with all of the pertinent large scale displays of fields as produced by the National Weather Service.

4. AN EXAMPLE OF OBSERVED AND MODEL PREDICTED WIND POWER DENSITY

A conspicuous and persistent feature of the wintertime model predictions of the wind power distribution in the Chesapeake Bay area is the landward minimum-seaward maximum shown in Figure 9.

Results from the morning of January 30, 1980 (Figure 10), show that for an actual wintertime case the observed power density is distributed in a pattern close to the model-predicted field.

The observed power density gradient, as well as the maximum value of the power density, is considerably greater ($\sim$ 3x) than the model-predicted values. The comparison shown in Figures 9 and 10, however, is between model output for an average wintertime condition and the observed fields for a strong cold outbreak. Model calculations initiated for the conditions prevailing prior to the morning of January 30, 1980, will be carried out.

Measurements of the wind shear from the aircraft and from the other systems could be determined. Along the seaward-most portion of the aircraft box pattern, between 50 and 150 m, the wind speed increased by only 0.5 m/s. (The 150 m value was 12.0 m/s.) Turbulent fluctuations were somewhat greater at 50 m than at 150 m. By contrast, in the locality of the landward minimum the wind shear between 50 and 150 m was at least 2.0 m/s. (The 150 m value was 6.5 m/s.) Furthermore, turbulence over land increased with increasing height.

5. CONCLUDING REMARKS

The field observations will be checked and compiled in a form (primarily magnetic tape) which can be used by ourselves and by others. All field data should be archived by 30 June 1980. Comparisons will then be made between the observed and model predicted wind and power density fields. These intercomparisons of observed and model predicted fields will allow us to place numerical bounds on the model estimates of power density. We will finally use these estimates of skill in predicting the coastal wind power distributions in a users handbook for determining the wind power potential of any given East or Gulf coast site or area (Garstang, Pielke and Snow, 1981a).

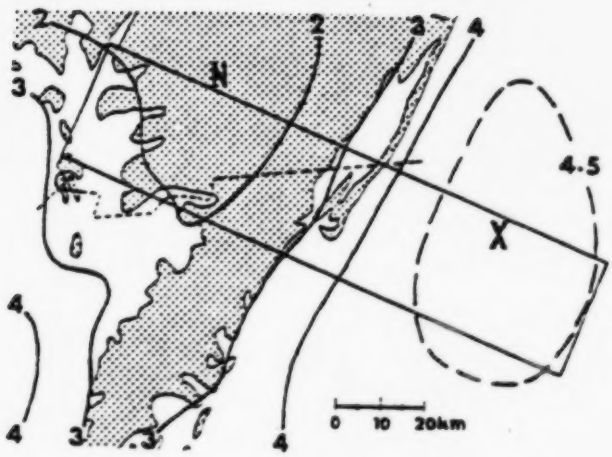


Figure 9. Isopleths of predicted wind power density (10^2 W/m^2 perpendicular to the wind) at 30 m above the surface in the southern portion of the Delmarva Peninsula. 'X' specifies area of maximum power density (4.7 x 10^2 W/m^2), 'N' specifies area of minimum (1.7 x 10^2 W/m^2). Predictions made by the University of Virginia mesoscale model for a wintertime situation at sunrise; large scale (geostrophic) winds from the north-northwest at 10 m/s, sea surface temperature, 8°C. Land areas are stippled, dashed line is Maryland-Virginia border. Superimposed rectangle is the aircraft box pattern.

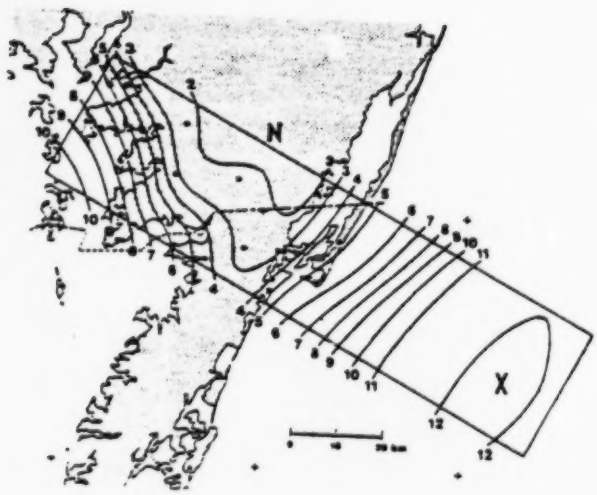


Figure 10. Isopleths of measured power density (10^2 W/m^2) at 150 m above the surface on January 30, 1980, 0740-0900 local time, in the vicinity of Wallops Flight Center. 'X' specifies area of maximum power density (approximately 1300 W/m^2); 'N' the area of minimum (approximately 150 W/m^2). Land areas are stippled. Open circles are land-based measurement locations. Solid lines are the aircraft box pattern, 120x30 km. Dashed line is the Maryland-Virginia border. The intersections of 75°00', 75°30' and 76°00'W with 37°30' and 38°00'N are marked. Winds were from the north0northwest.

6. REFERENCES

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